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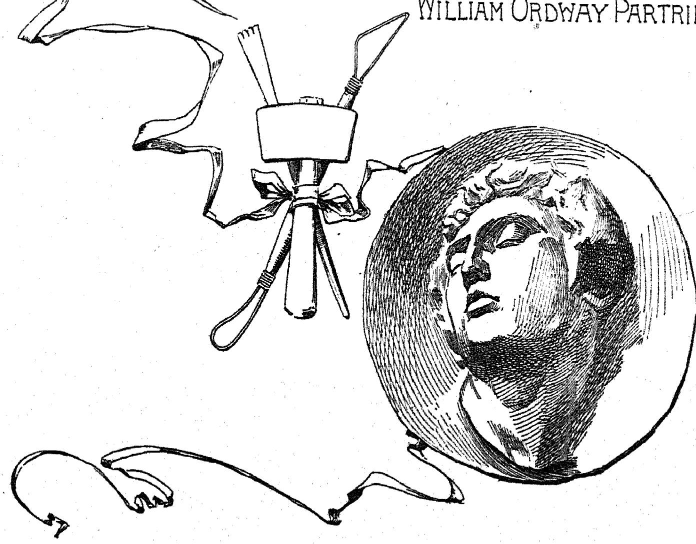
TECHNIQUE OF SCULPTURE

BY

WILLIAM ORDWAY PARTRIDGE.



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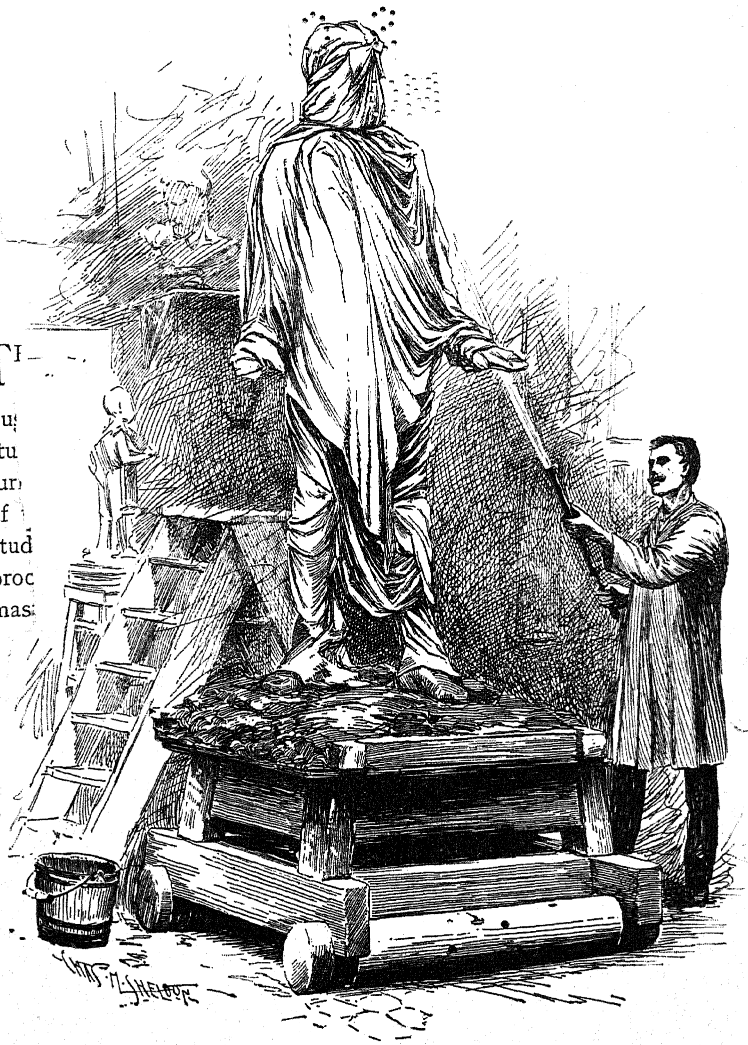

"SPRINKLING A STATUE."

PREFACE.

THE chief object in the publication of this book has been to offer a practical as well as a theoretical knowledge of sculpture. Suggestions have been made that may prove useful even to advanced students, although the author had in mind, mainly, the thought of furnishing a guide to beginners. A brief account has been given of the history of sculpture from prehistoric times, in order that the student might know how sculpture came to be, what the world has produced in this art, and what principles have guided the great masters.

The author has been led to undertake this work because of the many questions asked him regarding the technique of his art. Many still think that a sculptor, when he wishes to produce a statue, obtains a block of marble and carves directly from the stone. The whole process, from the working of the clay to the final execution in bronze and marble, has been gone over; sketches have been made especially for this book, designed to illustrate the difficult processes which it is next to impossible to describe by word alone. It is believed that these sketches will be of great value to the lay reader as well as to the professional student. The drawings were made with great care and especially for this work by Charles M. Sheldon and Vesper L. George. Much more might have been written; but brevity has been aimed at, so that the book produced might be easily handled. The author has drawn from every source possible. The data and facts contained have been gathered from

many men and books, and tested by actual experience. It is hoped that the work may not only fulfill its designed mission, and be helpful to the student who may have to work alone, but that it may lead to a more definite and sympathetic understanding and appreciation of the great, calm, and enduring art of sculpture.

In his book "Art for America" the author has attempted to show that sculpture is not declining, that so far from being a lost art, it is one that we have only now thoroughly discovered, and that the American people are actually on the threshold of an art era that may, if properly evolved, prove as beautiful, expressive, and inspiring as is the sublime sculpture of Greece. More nonsense is taught and written to-day about sculpture than about any other of the arts. It is full time we gave to this subject the serious consideration it merits. It has been the aim, in this book, to speak of the art as it really is, and the work is given forth with the hope that it may result in the creation, to some extent, of a fresh interest in sculpture.

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TECHNIQUE OF SCULPTURE.

PART I.

HISTORY OF SCULPTURE.

THE art of sculpture represents objects by a solid likeness to their forms. These are carved in relief or detached entirely from the background. In speaking of sculpture we may include figures in bronze or other metals, as well as figures in stone or marble. The desire to commemorate in some palpable form the memory of extraordinary events and persons was doubtless the origin of this art among men.

Sculpture is, literally, the process of graving or cutting hard material. The word is derived from the Latin *sculpo*. It is commonly applied to artistic carving or cutting. In this sense processes which do not, strictly speaking, involve the cutting of hard substances, are included in the term. Sculpture as a fine art includes, then, the molding of soft materials as well. Clay, and often wax, have been employed from the earliest times, either for making sketches or models for reproduction in marble or bronze, or as a vehicle for finished work.

Sculpture is the oldest of the arts. Long before the Scriptures were written we find products of it in ancient Egypt. It is the most enduring, as well as the most ancient, of all arts. The first savage

who scratched a design upon a flat surface was a sculptor, however crude his work.

From the beginnings of art in Greece, where it afterward found its most perfect expression, we may trace the entire history of a school of sculpture. The savage races of to-day have rude carvings similar to the prehistoric Greek. Among the Mojave Indians of the great desert of Arizona we find specimens of a crude handiwork, reminding us of the early dawn of Grecian art, which, in later years, reached its zenith and afterward fell into decay.

A child, beginning to model in clay, works in the same manner as did the early Greeks in the infancy of their art. The individual is an epitome of the nation. From this simile we may understand how sculpture arose. Not, however, until man had learned to control himself and to master the stubborn material which he found at his hand do we find anything worthy to be called sculpture.

The earliest statues were, in all probability, of men and not of divinities. Religious feeling later led to the giving of divine attributes to men and these forms began to appear in sculpture. The first traces of sculpture in connection with worship are found among the ancient Chaldeans.

Egypt. — We may pass over the sculpture of India, which is fantastic and grotesque, and come at once to Egypt. The grand and stately sphinx of Gizeh is, perhaps, the first great monument of which we have any knowledge which may be called a work of art. From its creation we may classify as sculpture the ideas which men have sought to put into stone and bronze, expressing their feelings for beauty and divinity as best they could. It is with such, rather than with the fantastic and untutored barbaric carvings, that we have to deal.

The Old Testament contains the earliest known names of sculptors. They were the artists employed upon the Tabernacle. They date

from about 1500 years before the Christian era. Of art in Egypt we have more certain traces. A molten calf and a brazen serpent, of which we read in the Scriptures as objects of worship or reverence, are evidences of art traceable to Egypt.

Assyria. — Sculpture is found among the Assyrians, and recent interesting discoveries have given the world much knowledge concerning the art of sculpture among this people. Especially in and about Nineveh, the ruins of which have been of late years uncovered, are evidences of it found. Assyrian sculpture was chiefly decorative and was used to record remarkable incidents in the history of the nation, or the valor of its kings. Many colossal figures have been found, combining the human with the brute, typifying the union of intelligence with force.

Assyrian sculpture exhibits an intimate knowledge of animal character and action. The reliefs with which the walls of apartments were often decorated, represented battles, sieges, lion-hunting, the crossing of rivers, and many details of everyday occupations. Every circumstance is noted. The vegetation of the country is shown; the animals in common use, and even the tools of the sculptors are represented.

Assyrian sculpture was evolved from the rude arts of the Chaldeans, although remaining undeveloped. We may say it dated from the twelfth century, B.C. It is conventional, in the main, but yet has distinct realistic elements. The action is fervid and spontaneous. This sculpture shows a remarkable knowledge of animal life and habit, as is evinced in the relief of the Wounded Lion, so familiar to art students.

That the Assyrians were skilful is readily seen by their clever execution. There was a prescribed form for treating the human figure. The same outline, as of one family, or even of one individual, is found in all the faces. There is in all the same square-cut, braided

beard. There is one expression throughout, a complaisant smile, which lights the countenance, no matter how serious the occupation. This is a curious characteristic of all prehistoric sculpture.

In considering the sculpture of Nineveh, it must be remembered that we are discussing the art of a city destroyed in the year 606 B.C., hence the *relievi* which we see in the museums, taken from the ruins of this city, are certainly upwards of 2500 years old.

In the later Assyrian sculpture one traces clearly the influence of the Egyptian. Indeed the sculpture and art of each people was largely influenced by their mutual intercourse. Assyrian sculpture cannot be classified among successful works of fine art. Though of clever execution, it is of a conventional type, and belongs to a fixed, not a progressive, school. It is chiefly interesting to us from an historical standpoint.

Persia.—Persian sculpture can easily be traced to an Assyrian origin. It was never developed into an art of beauty. National prejudice was against it and led the Persians to destroy the works of art of other countries. Xerxes was induced to destroy the temples in Greece, regarding them as impious, and statues were defaced under the same feeling of religious prejudice. The sculpture of Persia cannot be said to have a distinctive character.

China and Japan.—The sculpture of China and Japan need scarcely be considered. It is mostly of a mythological character, with monstrous combinations of human and brute forms, repulsive in their ugliness and in outrageous defiance of rule and possibility. The subjects are remarkable chiefly for their colossal dimensions and elaborate ornamentation. In fact, the striking feature of all eastern monuments is the vastness of scale and a certain tranquillity of expression.[1] In the art of bronze-casting

[1] With few exceptions it may be noted that the ruling sentiment of all early sculpture was repose.

China, however, has made great advances, some of the Chinese bronzes being the most wonderful in the world.

Neither China nor Japan has derived its knowledge of art from Europe. It is peculiar to them, and most interesting on this account. Chinese art was evidently the parent of Japanese art. It is less original, but has greater technical completeness and method. Chinese art is more restricted. The Japanese work bronze in a wonderful manner, inlaying it with other metals. Detail is most carefully and ingeniously wrought out, and shows spirit and freedom. Motion is cleverly represented, without destroying the artistic balance of the whole work. This art is chiefly decorative in idea and treatment. It is said that their creed and customs forbid the study of anatomy, which accounts for the bad modeling and drawing of the human figure, while other forms are cleverly given. In fantastic art they have no equals, and show peculiar talent for caricature. Their feeling for beauty is lofty, as their landscapes and bronzes of animals and birds well show. Dragons and weird monsters are shown, and water is imitated in bronze with marvelous fidelity.

What has been observed of the Chinese and the very odd Japanese sculpture is equally applicable to recent discoveries in some parts of South America. The interest in these subjects is chiefly for the scholar and the antiquarian, and has little or no connection with the progress of art. While the facility of execution shows long practice, no conjecture can be formed as to the date of these works.

Greece. — Having thus briefly considered the beginnings of the art of sculpture, let us pass on to Greece, where it reached its highest and noblest development. However original Greek genius may have been, its art was not indigenous. If one studies the lions of the gates at Mycenae, he recognizes Greek indebtedness to Assyrian influence. Greece absorbed, slowly and surely, all that was monumental, calm, and beautiful in Egyptian art, and in the

arts of the peoples along the shores of the Mediterranean. It is not difficult to trace back the Apollo of the Belvedere to the stiff Egyptian figure, with its arms locked closely at its side, and its body knit together in all the possible conventionalities of a tyrant-ridden people.

Greece was not limited to the little country which bore the name. We must think of her only as an influence, something like England of to-day, only higher in her civilization and broader in her culture. Her territory was largely mountainous, as is Switzerland. The small plains or valleys naturally brought men together and led to the building of cities, that, from their isolation, became different one from the other. While Greek life and language were alike throughout Hellas, the manifestations of that life and thought in sculpture and architecture were as different as French art to-day is different from that of Italy or Spain; yet each people was upon, or in easy access to, the sea, which was and is a great educator. They were in communication with all peoples and civilizations, more shut off from themselves than from the outside world, of which Greece was the centre. The Greek, as we learn from Homer, was an extensive traveler, and brought back whatever was worthy from foreign countries, to make it a part of his own dearly beloved land and her institutions.

The language was the language of Homer, as we find it in the Iliad. While thus one in thought and language, Hellas was still separated politically into about twenty different states, and was as much akin to Switzerland politically as it was geographically. Each state, however small, was perfect in its government, having its own customs, gods, creeds, and ideas. Historians tell us that such political and geographical conditions were most favorable to the development of genius in arts and letters. Active competition ripened all that was manly and progressive, through state pride. At certain great festivals men came together from all parts of

Greece, and a cosmopolitan idea was developed. A Greek not only knew the customs, politics, and arts of the state from which he came, but he learned, by this intercourse, to have a sympathetic respect for all.

The climate of Greece is most favorable to the development of art. One may sleep in the open air for more than one-third of the year. Excessive cold is as rare as enervating heat. Thus did the Greek escape the phlegmatic nature of the northern barbarian and the intemperate and sluggish nature of the south. The gymnasiums provided for the body, as did the groves of Plato for the soul and mind. To the Greeks the nude figure was the most perfect symbol of beauty which sculpture could embody. At the Olympic games the sculptors had an opportunity of studying the human form, under the most favorable conditions. These games of the Greeks were full of joy, and in preparing for them, men grew strong unconsciously. It is this joy of unconscious strength that makes Greek sculpture preëminently beautiful. In these games, both men and women were wont to exercise entirely nude; at least this was the case in Sparta. The passion for pure beauty seems to have dominated all other passions.

The Greek demanded not only perfect form and complete technical knowledge, but asked, moreover, that the subject be at once agreeable and noble. In action, pose, drapery, and idea, in the rendering of force and passion, he was required, by public feeling, to avoid the ugly, extravagant, and ignoble. At Thebes there was a law to this effect. The one thought and aim was to uplift humanity, by keeping before it the most perfect physical form. Indeed, prizes were offered at public competition for the most perfectly developed forms, both of men and women.

The Greek not only detested the ugly, but he avoided, from instinct, all exaggeration and caricature. Artifice and trickery had no place in an art where beauty was the sole aim. Impiety was

thought to be impossible in a beautiful man or woman. The education of the Greek was as many-sided as was the beautiful land he inhabited. It included in its curriculum the intellectual, physical, moral, political, social, and æsthetic. Every side of the man was rounded out, and he came forth from the schools, and remained, a cultured being. Imagination grew naturally, as a tree grows, under benignant skies.

From these conditions it is readily seen that sculpture rose spontaneously, and could not help reaching its highest possible development. Spiritual beauty, expressed in the most perfect physical form, was what the Greek nation demanded, and what the Greek sculptor gave.

In the Æginetan marbles, produced fifty years before Phidias, is struck the first sublime note of Greek sculpture. Myron, who preceded Phidias and was his elder, is known to us through his Discobolus. Among the Greeks he was held in high esteem for his animal sculpture.

Fifth Century, B.C. — The art of sculpture culminated in Phidias, a contemporary of Socrates and Sophocles. No fragment has ever been discovered of that wonderful statue of his creation, the Athena Promachos, which stood upon the Acropolis, terrifying the invader. The frieze and two fragmentary pediment groups, together with the metopes, are all that remain of the sculpture of the Parthenon, probably the most perfect building in proportion and rhythmic beauty that the world has ever known. These fragments indicate the handiwork of a symmetrical, firmly poised mind, and a hand thoroughly trained to execute its dictation. The handling, while broad and simple, exhibits a subtlety of finish, in the relation and value of plane to plane, that would fascinate one with its details, were one not impressed at once with the beauty of the whole. Art, here, is free from all conventional restriction, although it is evident

that the work was carefully planned before chisel was put to marble. This is shown by the adaptation of each figure to the place it fills. All this, too, shows a consummate knowledge of composition and a mastery of its principles. The pediment groups represent incidents in the life of Athena. The stately march of the processions in the frieze charms us without wearying. What calm joy pervaded these pagan festivals!

One cannot leave Greek art without glancing at the stately female figures, known as the Caryatides of the Erechtheum, bearing so lightly and so elegantly, and with such unconscious grace, the weight of the entablature. The chief attraction and characteristic of the Phidian epoch is the sublime dignity and calm serenity that invests all sculpture and architecture. It was an age of great men, — of Phidias, Æschylus, Sophocles, and Pericles.

The Neo-Attic school shows Greek art in its decadence, although charm and beauty have not forsaken it. The works of Praxiteles and of his contemporary, Scopas (400–350 B.C.), are full of an undulating loveliness. Art has now lost much of its sublime quality, but gained in sensuous beauty. The famous Hermes, found among the ruins of the temple of Hera at Olympia, in 1877, and perhaps the Venus of Melos, discovered much earlier, belong to this epoch.

The name of Praxiteles is the second among the great names of Greek sculptors. His work was less grand and noble than that of Phidias, but more sensuously beautiful. Although many of his statues are wholly nude, they bear no trace of licentiousness. The famous Hermes, mentioned above, although considerably mutilated, is regarded as one of the most beautiful pieces of sculpture in the world. At the date of its creation, art had still its canons of modesty. Good taste was not yet degraded by the sensuality that followed upon the death of that great sculptor, which occurred soon after the year 350 B.C.

The love of Praxiteles for pure beauty must have amounted to a passion. His art was beautiful in its symmetrical grace and refinement of contour. It represented the tender emotions of mankind. Cicero speaks of the wonderful expression with which his faces were endowed. His Venus of Cnidos was held by the ancients to be his masterpiece, and second only to the Jupiter of Phidias. Love was still spiritual as well as physical. Grecian civilization, giving way slowly before the advancing Roman, allowed art also to lose its divine calling and to become a pander to the lusts and ambitions of men.

Lysippus, adjuring all conventionalities, strove manfully to uphold its dignity; but one man could not stay the fell tides of decadence. It was he who created the fine athlete, called the Apoxyomenos, now to be seen in the Vatican.

To be a great artist, in Greece, was to be the equal of the greatest in the land. How different with the Roman, who affected all that the Greek actually was! To practice the fine arts in Rome was considered trivial and effeminate. The gross, sensual nature of the later Roman could not grasp the calm pleasures of pure form.

The decadence from Praxiteles is rapid, until the lovely art of Greece is entirely debased by the conquering, domineering Roman. The history of Hellenic art, its rise, palmy period, and decadence, which we can intelligently follow through the writings of the historians of Greece and Rome, in the light of modern research, we may take as an exemplar of all schools of art. In each the same sequence is shown.

Rome. — It was from Greece that Rome inherited almost all that she knew of sculpture. Something, undoubtedly, she possessed in Etruria. Etruscan sculpture, although lacking in creative genius, must not be wholly overlooked. We know very little of these early inhabitants of this part of Italy. Their architectural remains are of

great antiquity. We do not know whether the early colonists came from Egypt or Phoenicia, or Asia Minor. The colossal way in which the Etruscan ruins are constructed points, perhaps, as much to Egypt as elsewhere. Greek influence is plainly seen in whatever of Etruscan sculpture has come down to us, although the style is sometimes original. Some tombs have been lately discovered in Volterra and adjacent Etruscan cities, representing figures reposing upon sarcophagi. These figures form the covers of the sarcophagi, the dead having been placed in the receptacle below. Their forms lack elegance and are clumsily draped. The faces are believed to be portraits. Some approach beauty and are often pleasing in expression. From their appearance they might easily be attributed to the debased Roman school.

Of special interest in Etruria is the undoubted fact that all the art Italy had before she began to borrow from Greece was found in this province and is now called Etruscan. From Etruria Rome received many of her religious and political institutions as well as the greatest, perhaps, of her kings. The majority of the statues of Etruscan deities discovered are winged, as were those of Assyria. The greater portion of this work is done in terra-cotta ; marble seems to have been little known or used. From the East, probably from Phoenicia, the Etruscans learned the art of working metals and practiced it with great success. Etruria was filled with bronze statues, most of them statuettes, some colossal. A portion of a chariot, found at Perugia (now at Munich) shows crude monsters, which resemble Assyrian work. The Etruscans were a race of imitators. Having taken their art beginnings from the East, as did Greece, they advanced but little and clung to archaic forms, which the Greeks soon threw off. Etruscan art lacks ideality ; it is, for the most part, materialistic art and realistic portraiture. The Etruscans were ingenious and industrious, and developed technical skill sufficient to make them known at Athens and popular at Rome. We

know them to have been an opulent people, but lacking in refinement and given over to sensual enjoyments.

Both the British Museum and that of the Vatican possess many fine examples of their work in metals. The mountings of their ornaments and jewels were peculiarly beautiful, elaborate in design, and delicate in workmanship. Lacking in the fine physical development of the Greeks, they were accustomed to give to their work an extreme realism, thus widely varying from the Greek idea. We find among the names of Etrurian sculptors those of Volcanus of Veii (B.C. 616–578), who was employed by Tarquinius Priscus to make an image of Jupiter for the Capitol; Mamurius Veturius (B.C. 716–673), employed by Numa Pompilius to make a certain shield, like the sacred one which he thought had fallen from heaven.

In the toreutic art (metal-working) Etruria seems to have been especially successful. In the best days of Grecian art Etrurian goblets of gold, silver, and bronze were eagerly sought. Among the most beautiful of this work are the *cistae mysticae*, or cylindrical caskets of bronze, richly ornamented with graphite figures. The finest of these yet found is attributed to Novius Plautius. It was discovered near Palestrina in 1743. The date of its execution is probably about 250 B.C.

Historians do not mention a single native Roman sculptor. In arts, as in letters, the Romans borrowed from the Greeks. They were a people to whom the real was the most important thing in the world. Their sculptures are chiefly images of the Caesars and their unscrupulous wives, and of favorites of the day. Their statues were manufactured before they were needed, and heads were added to suit the reigning sovereign. The most complete collections of effigies of the Roman emperors extant is to be found in the Uffizi gallery at Florence, and the museum of the Capitol at Rome. The busts of Caligula and others are modeled with a vigor and technical power not unworthy of the modern French school. They are dis-

tinctly portraits. Augustus, Trajan, and Hadrian are favorite subjects. The Marcus Aurelius on the Capitol in Rome is one of the most famous equestrian statues in existence.

The Emperor Augustus boasted that he found Rome of brick and left it of marble. A taste arose among the Romans for collecting ancient works of art, a taste akin to the eagerness with which collectors search for old masters in our times. Cicero arraigned Verres for the base and ignoble manner in which that robber took from Sicily her finest works of art. Caesar encouraged the fine arts and planned many improvements which Agrippa afterward carried out. The noble temple called the Pantheon of Agrippa still remains intact. This was filled with statues of the gods. It was this building in which the Roman achieved his greatest architectural triumph.

Caligula and Nero, each in his time, aided in the spoliation of Greece. Not in time of war, but in time of peace, Caligula sent out an expedition under Mummius Regulus (consul, 31 A.D.) to bring away, by downright robbery, all the best statues from the Greek towns to adorn his villa. The Eros of Praxiteles is said to have been stolen by this expedition.

Thus Rome became the treasure house of Greek sculpture. It must have produced a refining influence upon the cultivated Romans; and, indeed, Roman literature tells of the rage for the possession of fine statues that became fashionable in Rome. It is recorded, to their glory, that the populace showed signs of mutiny when the statue of the Apoxyomenos was taken from the Baths of Agrippa to the chamber of Tiberius. A certain taste for the fine arts was developed, no doubt, in the Augustine age; but creative genius was scarcely alive.

The popular taste for fine arts in Rome finally resulted in the development of a school which may be called Graeco-Roman. To this school belongs the famous statue known as the Venus de Medici, now in the *Tribùna* at Florence. This statue was found in

fragments in the ruins of the Portico of Octavia at Rome. It was the work of Cleomenes, son of Apollodorus, a Greek artist living in Rome in the first or second century A.D. This statue cannot be said to be distinguished for its modesty, although the subject affects a modesty that makes the lack of it only the more apparent. The ruins of the Baths of Caracalla have yielded some good statues, among them the Farnese Hercules.

The rise of Christianity marked the decadence of sculpture. The early Christians regarded it as idolatrous to copy the human form, and many fine specimens of Greek and Roman sculpture were by them defaced or destroyed. In the sixth century art showed signs of awakening at Byzantium. Its inhabitants were noted for their skill in the cutting of precious stones and the working of metals. The influence of these people and of their art was widespread, and continued until the twelfth century. In this period Germany threw off Byzantine influence; but her Gothic period is scarce worth studying in sculpture. In the fifteenth century, Albert Dürer produced wood carving, and art again advanced. The notable names of this period are Adam Krafft (1430–1507) and the Vischer family (1435–1529). Their best work followed a Gothic ideal. Their figures were flat and square, and were clothed in drapery which hung in stiff, wood-like folds.

The Gothic Period.—The Gothic period lends its virility to sculpture as well as to architecture, and infuses into it a stern realism, unlovely but interesting. In the fifteenth century the figures that are found upon the Cathedrals of Chartres and Rheims, though Gothic in style, betray the classical influence. Here again, however, sculpture declined, and the fourteenth and fifteenth centuries produced little of merit. It must be borne in mind that this result was chiefly the effect of the invasion of Europe by Attila and other barbarian leaders. A merciless horde had swept from east to west,

crushing and destroying civilization, mutilating and breaking to fragments all monuments of art which it encountered. Before this invasion the empire of Rome fell, and for many years European civilization was plunged in darkness. It was the age of utter human degradation. There was nothing worthy of artistic representation, and art lay fettered and dormant. Out of this darkness the first glimmer of artistic feeling is seen among the Goths, the most intelligent of the invading nations.

The Italian Renaissance. — The first sculptor who dared to awaken art from her long and profound slumber, and to stamp upon her the vivid imaginings of his own genius, was Niccolò Pisano. He has been fitly called the father of modern sculpture. We hear of him first in the early part of the thirteenth century, and he was, as his name implies, a native of Pisa. He practiced, as was common with the early artists of this period, three arts — painting, architecture, and sculpture.

The revival of sculpture in Italy preceded that of painting. What sculpture we have, before Niccolò, is awkward indeed, and burdened with trivial detail. We know little of the history of this wonderful man; we are told he did his best work between the years 1260 and 1278. It is his sculpture in relief that is especially worthy of being studied. His reliefs are scattered through the towns of northern Italy, especially Pisa and Siena. One seems to trace clearly in his work the influence of Greek sculpture, and yet the design and sentiment have characteristics which may certainly be called original. No doubt the ancient sculpture which had been preserved in the Campo Santo of Pisa had its effect upon his style and technical execution. We know that, together with his son Giovanni (born 1245; died 1321), he was a close student of this Greek work. His son, although less great, may be called a true artist. He too often sacrificed harmony and charm to expression and action.

Following him comes the wonderful Giotto (Angiolotto, born 1276; died 1336), pupil of Cimabue. He modeled the reliefs upon his beautiful campanile in Florence. He was greater as a painter and architect, however, than as a sculptor. He was a friend of Dante, a copy of whose portrait, painted by him, may be seen upon the walls of the Bargello, in Florence, to this day. His influence upon Italian art was unbounded.

Andrea Pisano (1305–1359) did work in sculpture similar to that of Giotto, but worse rather than better. He was one of the first to abandon the Gothic style and adopt the models of ancient Greece. Now comes Orcagna (Andrea di Cione — born about 1325; died 1376), who, with his marvelous creative genius, and his chaste and simple style, surpassed all his predecessors. His masterpiece is a shrine, in Or' San Michele, in Florence, to the Madonna,— comprising reliefs depicting her life, cut out of white marble. He reëstablished the laws of perspective, and was great as an architect and fresco painter as well as a sculptor. He was the author of the famous frescoes in the Campo Santo at Pisa.

Donatello (1383–1466) adds another great name to art, a name of rare and original genius, the crowning qualities that make up the idealist and realist in happy fusion. He was famous for his low reliefs, which are now scattered throughout the world. He was remarkable for his power and truth of expression; his character was noble and generous. His best known statues are those of St. George and St. Mark, on the outside of Or' San Michele, in Florence. He was a lover of children, with a rare faculty for catching their illusive forms.

Lorenzo Ghiberti (1378–1455) came now to create and execute the famous gates of the Baptistery at Florence, upon which he spent twenty years of his life, and which Michael Angelo declared to be "fit for the gates of Paradise," but which, however beautiful, tend to the degradation of sculpture into the picturesque, rather than to its elevation into the purely sculpturesque. His style was

graceful, dignified, and harmonious. In his own day he was famous, and his fame has lost nothing in five centuries. Ghiberti's successor was Sansovino (1460–1519), who carried on the even, harmonious, serene style of his predecessor.

Now comes a change in Italian art, whose foundations are splendidly shaken as Michael Angelo steps upon the scene. Michael Angelo Buonarotti (1474–1564), trained thoroughly in the technique of his art, was a lover, all his life, of the antique. His style is vigorous to the point, sometimes, of exaggeration. Into all his marbles he breathed his own passionate, turbid, intellectual, poetic nature. He loved devotedly his native city, Florence, and fought in her defense until the downfall of her liberties. The tyrant who came after him had sufficient wit to value and conserve his art, although destroying all from which it arose. His sculpture is tragic, terrible, never to be forgotten when once seen, not unlike his lonely, ascetic life. He was greater as a man, perhaps, than as an artist, full of sweet thoughts and great tenderness. His is altogether the greatest and most interesting name among the Italian sculptors. He touched life on every side. His Moses is perhaps his greatest work. What lessons of tireless energy and unswerving purpose are to be learned from it! He sacrificed ideal beauty often to his intense love for expression and dramatic action. The "Night" and "Dawn" on the tombs of the Medici at Florence are incarnations of despair, resistance, and endurance. The Lorenzo de Medici is full of steady resolution and lofty thought and purpose, power in repose, latent force, concentrated life. It is the intensity of these conceptions, their terrible seriousness, that saves them from the bane of realism. The sweet, sad resignation of the Madonna della Pietà in St. Peter's exhibits the delicate and tender side of his genius, too often overridden by his desire for fervid expression. His chief fault seems to have been impatience. Many of his works were ruined by his chipping off a piece too deeply in

his impetuosity. His impatience led him often into exaggerations. Those who studied with him copied his faults, but failed of his genius. He had many imitators, but no worthy successors. His greatest work, as a painter, is the decoration of the ceiling of the Sistine Chapel in Rome.

Some of his contemporaries, however, are worthy of mention, notably Benvenuto Cellini (1500–1570), whose autobiography is well worth reading, and who made the famous Perseus. He was given to affectation at times, and was over fond of detail. He excelled in gold-working and engraving. His medals have won universal admiration. His style was graceful and charming, rather than grand.

John of Bologna (1524–1608) shows more power than Cellini. Many critics have pronounced him second only to Michael Angelo. He was a friend of that master and one of the first members of the Academy of Florence. His best known work is the "Flying Mercury" in the Bargello at Florence. He received his name from the famous fountain which he built at Bologna, with a colossal figure of Neptune. His style was gay and spirited.

Sansovino (Jacopo Tatti, 1479–1570) has left much interesting work in Venice, where he settled, although a Florentine by birth. His style tended rather to exaggeration. His masterpieces are the four Evangelists in the chapel of St. Mark's and colossal statues of Mars and Neptune in the Doge's Palace. He displayed also much talent as an architect.

The inordinate striving for expression, which now prevailed, brought about a quick decadence in sculpture. Here and there are single works that show that the great style was not entirely lost. The beautiful statue of St. Cecilia lying dead, at Rome, was done by Stefano Maderno (1576–1636). This was his only fine work. His contemporaries did nothing as fine, and little above the commonplace.

Among the famous sculptors of this era were the Della Robbias: Luca, Andrea, and the sons of the latter. Of these, Luca, born 1390 or 1400, was the eldest and the most famous. His bassi-rilievi, adorning the campanile of the cathedral of Florence, are still seen and much admired. Perhaps his most famous work is the sculptures in relief designed for the front of the organ-gallery in the Duomo at Florence. This work, in high relief, represents groups of boys and girls, youths and maidens, singing, playing upon instruments of music, and dancing. In every group are a charming freedom of action, grace of attitude, and elegance of flowing drapery that are unsurpassed. Andrea della Robbia, a nephew and pupil of Luca, and scarcely less famous, was born in 1435. Simone, a brother of Andrea, was also a sculptor of some note, and of the seven sons of Andrea, five followed his profession. The reliefs and statues of Andrea della Robbia are found all over Europe. Many of his works may be seen in the church of Santa Maria delle Grazie, the convent of Vernia, and in many of the churches of Italy. Two of the sons of Andrea, Paolo and Marco, became members of the Dominican order of monks under Savonarola, and added to the artistic fame of the order.

The work of the Della Robbias is characterized by its lofty purity and almost Greek simplicity of style and treatment, to which artistic virtues we may add that of a distinctively tender quality.

Spanish Art.—Spain has produced greater painters than sculptors. Good work has been done in wood-carving, and much is decorative. Two men have been famous, Alonzo Berruguete (1480–1561) and Gasparo Becerra (1520–1570). These both were pupils of Michael Angelo. The first restored the Alhambra and executed important works at Madrid. His masterpiece was the choir of the cathedral at Toledo. The second executed the famous statue of the Virgin at Madrid. The Spanish learned their art from the Italian masters.

Their school is characterized by strong effects of light and shade, making their art fervid and dramatic. Most of all did they care for expression. One sees the effect of their religious training in the severity and passion of their art. The nude is seldom met with. Their madonnas and saints breathe an air of enthusiasm and devotion that fascinates the beholder.

The Modern Era: German Sculpture. — Byzantine influence continued to dominate German art until the twelfth century. In Cologne and the Rhine provinces creditable work was done in toreutic sculpture. On a font at Liège are some remarkable reliefs, baptismal scenes from the New Testament, by Lambert Patras of Dinant. These were executed about 1112. They display a certain crude beauty.

In the Merseburg Cathedral is a figure of Rudolph of Swabia in bronze, interesting because of its realistic treatment. In the Hildesheim Cathedral is a choir-screen executed in stucco, and once gilded and colored, a series of large reliefs broadly handled, noble in conception, and draped with true classic feeling. This is one of the finest pieces of twelfth century sculpture.

During the thirteenth century Germany did not attain as great a distinction in sculpture as France. The golden gate of Freiburg cathedral, however, displays progress. The sculptured figures on the jambs are cleverly executed. French influence may be clearly traced in these works (1270). There are also statues of the apostles upon the pillars of the nave, and one of the madonna at the east end, which display singular breadth and beauty.

At Bamberg, in the market-place, is an equestrian statue of Conrad III, resting on a foliated corbel. This shows originality and virile power, and is designed with a remarkable knowledge of artistic effect.

At Brunswick, of the same period as Conrad III, are to be seen two fine statues, dignified and beautiful in expression, representing Henry the Lion and Queen Matilda.

Some of the finest sculpture of the thirteenth century is to be found in the cathedral at Strasburg. A "Death of the Virgin" (a tympanum relief), surrounded by sorrowing apostles, is a work of wonderful beauty, in advance of the period. Of its kind the decorative carving is as fine as any extant. The foliage is studied with the greatest love of nature, and is carved with the joy of devotion to chosen work.

Nuremberg is rich in sculpture of the fourteenth century. St. Sebald, the Frauenkirche, and other churches are decorated with statues and reliefs that, taken as a whole, produce upon one a feeling of richness.

The fountain of Heinrich der Balier of this epoch is richly decorated with color and gold, and adorned with statuettes of noticeable beauty. In the museum at Augsburg may be seen several large statues carved in wood, exhibiting nobility and dignity of treatment. This town produced a number of able sculptors of whom she is justly proud.

On the exterior of the choir of the church of Marienburg Castle is a remarkable colossal figure of the Virgin, built of hard stucco and adorned with mosaics of glass.

At Prague, in the market-place, is an equestrian group in bronze of "St. George and the Dragon," which is well executed and vigorous, but defective in style. In the Cologne cathedral is a fine statue in bronze of Archbishop Conrad, noble in style and evidently a good portrait.

The military portrait statues in Germany, and indeed everywhere, of this time, were stiff and lifeless of necessity, being disfigured with plate armor. The ecclesiastical chasuble which was also much used does not lend itself to plastic representation.

The fifteenth century produced many artists of marked ability. Much excellent work was done in the decoration of wooden altars with

statues and reliefs. The work of this century seems to have been largely in the order of church decoration. The choir-stalls in Ulm cathedral, dating from about 1474, were executed by one Jörg Syrlin, probably the ablest sculptor of the epoch. Wohlgemuth (1434–1519) under whom Dürer studied, was a wood-carver of no mean ability. Dürer executed in boxwood many reliefs of great interest.

Another distinguished sculptor of this time was Adam Krafft (1455–1507). The great Schreyer monument at Nuremberg was executed by him. This monument is criticised because of its mannered style and pictorial, rather than sculpturesque, effect. He produced also the great tabernacle, eighty feet in height, for Ulm cathedral.

We now come to the famous Vischer family of Nuremberg, which produced the ablest sculptors perhaps of the fifteenth and sixteenth centuries in Germany. Hermann Vischer still clung to mediæval traditions. Peter Vischer, the son of Hermann, was the chief artist of this family. Few sculptors of bronze have ever excelled him in technique; his style, however, suffers from the mannerisms and realistic tendencies of the day. He lacked moderation. The splendid shrine of St. Sebald with its luxuriant decoration is by him. It is a marvel of fine and delicate workmanship. Its slender, graceful columns are very beautiful. He was assisted in his work by his sons. The general design is Gothic. Every available space upon the canopy and its supports is covered with carvings of dragons, foliage, and grotesque figures. Time and labor were given unstintingly.

After Nuremberg, Augsburg is perhaps the chief centre of bronze sculpture. In a quaint church of Innsbruck is a series of bronze statues, twenty-eight colossal figures, surrounding the tomb of the Emperor Maximilian, and representing his ancestors. The finest figure of the collection is undoubtedly an ideal statue of King Arthur of Britain, of noble mien and excellent pose.

During the latter part of the sixteenth century is clearly seen the influence of the later Italian Renaissance. The sculptors are biassed by the style of Giovanni di Bologna. The seventeenth and eighteenth centuries in Germany were periods of swift decadence in sculpture. Some good portrait figures were produced, but no monument of any artistic value. A strong revival is noticeable in the latter part of the eighteenth century, and since then Germany has produced much sculpture of little real value. It is great in point of size, but is lifeless in conception and feeble in execution. One may class it with much other pseudo-classical sculpture of the century. The work of Rauch (1777–1857) has been praised beyond its merit. His recumbent statue of Queen Louise at Charlottenburg is sentimental and mannered. He seems to have been the best known man of the epoch. Albert Wolff shows a more virile power. Augustus Kiss (1802–1865) produced the famous "Amazon and Panther" bronze-group in the court-yard of the royal palace at Berlin. This sculptor wrought only in bronze and other metals. The sculptor Rietschel displays more ability than any of his contemporaries. A man who has achieved more reputation than he deserved was Schwanthaler (1802–1848). He is the author of the colossal bronze statue of "Bavaria," second in size only to the liberty statue by Bartholdi. He was patronized by King Louis of Bavaria. In our own immediate time German sculpture has thrown off its weak conventionalities, and shown decided vigor and individuality.

Modern Italian Sculpture. — The eighteenth century produced no men of great genius in Italy. We find, at Naples, Corradini and Sammartino producing many statues devoid of any sculpturesque worth. Art was lost in artifice. A deceptive realism had taken the place of the noble art bequeathed to Italy by Michael Angelo and Donatello. The middle of the century inaugurated the classical

revival which was destined to spread throughout Europe. The leading figure of this movement was Canova, the most popular sculptor of his time. He aimed at a classical perfection, which Greece had achieved once and forever. His work had a certain grace which was trivial rather than noble. His finest group is that which represents "Theseus slaying the Minotaur," now preserved at Vienna. He achieved distinction for his monument to Pope Clement XIII, in St. Peter's at Rome. The lions here are strongly modeled, but not with the sure knowledge that Barye and other French sculptors have since brought to animal sculpture. His tomb to Titian at Venice is entirely pictorial. Posterity has assigned to him much less fame than that given during his own time.

Certain critics have called Bastianini of Fiesole truly great. His style is that of the famous Florentine sculptors of the fifteenth century. Indeed, some of his work has actually been sold as veritable fifteenth century production.

The leading sculptors in Italy to-day are Vela, author of the "Dying Napoleon," of world-wide repute; Monti, whose technical ability has gained him some distinction; and Rossa, of rather too florid style. One cannot apply the adjective great to modern sculpture in Italy. It is a transitional period with the Italian people, and their art exhibits this lack of poise. A criticism that may be made upon it all is, that it is picturesque and trivial, rather than sculpturesque and dignified.

French Art. — When Gaul became France under Clovis, ignorance and bad taste were so universal that, if creative genius in sculpture existed, it was not permitted to come to the surface. At the beginning of the eleventh century, the dreaded year 1000 having passed by in safety, the art of sculpture appeared in France. The influence of the crusades is seen in the religious edifices, and in the rude sculptures belonging to the age of St. Bernard. Little by

little French sculpture threw off the Grecian and Byzantine influences in which it had originated and became Gothic. There is little use in lingering long over the thin, dry, and suffering figures produced by the early sculptors who were mostly monks. The early spirit was hostile to the study of the nude, and indeed to beauty itself. It was virtue, and not beauty, men demanded. They had not spiritual insight sufficient to recognize that true beauty is one with virtue. Shoulders and hips were forbidden to be represented, and the hands must be always folded in meditation or prayer. Expression was sought through grimace or contortion. The Christian of that day evidently attempted to supply the interdicted beauty by strained expression. Early French art is utterly devoid of that calm moderation and sweet beauty which made the Greek art so lovely and enduring. The sculptors were in accord with the prevalent ideas of their time. Art reflected the state of society.

Through the twelfth and thirteenth centuries we find sculpture becoming more secular. It has passed from the hands of the monks to the care of the bishops, and these bishops were less subject to the Pope than the monks, strange as it may seem, and permitted a greater variety of subjects to be represented in sculpture. Old legends were abandoned for New and Old Testament subjects.

Some groups of great interest were now produced, and an actual Renaissance was dawning for France. The artist's liberty became more and more wide. The work of the time shows not only a democratic tendency, but a true classic feeling in choice of attitude and arrangement of line. The artists of this time seem to have known the laws of sculpture. Their statues and reliefs are well adapted to the positions they occupy. The sculpture of this epoch is entirely decorative and cannot be separated from architecture. The Christian cathedral was a representation, in a way, of the world, and as artists freed themselves from priestly interference, the cathedral became a picture of the universe. Anything

may find representation in it — men, demons, angels, gods, plants, symbolical subjects, dragons, and anything that the fancy may conceive or the eye actually see. The cathedrals of Rheims, Chartres, Amiens, and Paris, are decorated according to this idea. In the fourteenth century we have the names of Jean Ravi and his nephew Jean Bouteiller, sculptors who worked together upon a life of the Virgin in relief about the cloister of Notre Dame in Paris.

Michael Colomb (1431–1514) executed many notable works. One of the rooms in the Louvre bears his name. He is the author of a famous bas-relief representing the struggle between St. George and the dragon. It is spoken of as a work of great delicacy of handling and boldness of conception, and quite worthy of Italy at that fine period of her Renaissance.

Jean Juste of Tours executed a tomb of Louis XII that has made his name known to us, and Jean Texier, by his forty-one groups in the Chartres cathedral, has become famous. David said, "It is Raphael himself, as seen in the loggia of the Vatican." Two famous tombs in the same room as the alabaster statue of Louis XII, which show careful chiseling and fine feeling, are the work of unknown men. They are preserved in the museum of the Louvre because of their native simplicity, and show the state of French art before it was changed by Italian influence.

We come now to the famous name of Benvenuto Cellini, invited to France by Francis I. It was now that the French imbibed the grand style of that masterful Italian school; and a French sculptor, John of Bologna, was destined to become famous among Italian sculptors. His work has been described elsewhere.

And this brings us to Jean Goujon (1530–1572). This name is famous in the annals of French sculpture; he has been called the French Phidias. His "Deposition from the Cross" is now in the Louvre. Upon the "Fountain of the Innocents," a most beautiful

conception, which was designed by Lescot in 1550, are nymphs of ideal beauty, with long and subtle figures. These nymphs, with their water-jars, have been often reproduced and sent over the known world. Jean Goujon has been called the restorer of sculpture in France. Others, again, have given him the title of creator of French statuary. He is supposed to have been born about 1530.

Germain Pilon (1515–1590) was an energetic, skilful sculptor; he executed the tombs of Francis I and Henry II. The Louvre contains a collection of his works. A famous group by him represents three women supporting a gilt vase, which was intended to contain the hearts of Catherine de' Medici and Henry II. The group is known as "The Graces."

For a long time French sculpture appears to have been employed chiefly in the decorations of tombs. Jacques Sarrazin and Pierre Puget (1622–1694) are distinguished names. The latter, in particular, is said to have resembled Poussin in his enthusiasm for independence and beauty of character. Like Poussin, Puget became disgusted with the gilded slavery of the court life and with inspectors of fine arts, and gave himself up to solitary study. He was painter and architect, as well as sculptor. He has been called the French Michael Angelo. He was original, but eccentric, giving himself over to his moods as a guiding genius. Like Michael Angelo, he often attempted to work directly in marble, without any previous sketches. He lacked taste and knowledge of the antique. One of his famous groups is the "Milo of Crotona devoured by a lion." Wonderful are the action and life of the figure, and the finished execution. The group has been said to rival the famous "Laocoön." It is considered the masterpiece of Puget. No work was too difficult or too complicated for his genius. He seems to have lacked a calm sense of proportion and moderation. His last group was that of "Alexander and Diogenes," finished at the age of 74. His old age was, like that of Michael Angelo, productive and laborious.

The work of Antoine Coysevox (1640–1720) resembles that of Puget. He was the author of the Mausoleum of Cardinal Mazarin, and many busts, notably those of Pierre Mignard and Charles Le Brun, said to be good portraits, and certainly creditable works of art. The two brothers, Nicolas and Guillaume Coustou (1658–1735), produced, the former, the group in the Tuileries garden, known as the "Junction of the Seine and Marne," and the latter, that of the famous riding-masters of Marly, now placed at the entrance of the Champs Elysées. A single work by certain sculptors has rescued their names from oblivion, such as "Leda and the Swan," by Jean Thierry (1669–1739), the "St. Sebastian at the Pillar," by François Coudray, and a "Hercules vanquished by Love," by Joseph Vinache. "Prometheus and the Vulture," by Nicolas Sebastian Adam (1705–1778), is a powerful piece of work, and, last is a "Charon," remarkable for its gloomy and reserved strength, whose author's name, alas! is unknown.

In the room of the Louvre devoted principally to Edmé Bouchardon (1698–1762), containing mostly works of the eighteenth century, the florid and effective style of the era is everywhere visible. The style of this sculptor is correct and large, but it lacks fire and enthusiasm. The statues of Christ, Mary, and of eight apostles, which adorn the church of St. Sulpice, are worthy of attention, as well as the sculptures of the Rue de Grenelle fountain. A pleasing statue by this sculptor is that of a young girl holding a stag by a cord, in the Louvre; the graceful attitude, the lovely head, and delicacy of the execution in the whole work, recall the antique in in many ways. In the same room which bears Bouchardon's name, is a "Psyche" by Augustin Pajou (1730–1809); upon the pedestal is the following inscription, "Psyche lost Love in wishing to know him." His wit seems to have been greater than his genius. The statue may be classed as a poor affair. Some of his busts, however, have won distinction for him, notably the lifelike portrait of Buffon.

We come now to the room named after Houdon, which contains not only his work, but that of many of his contemporaries. Jean Antoine Houdon (1741–1828) is one of the great names in the history of French sculpture. His best work, perhaps, is to be seen in the Théâtre Français, rather than in the Louvre. His bust of Molière, in the lobby, and the famous statue of Voltaire, in the vestibule, have won for him enduring reputation. He has combined, with rare tact and true poetic insight, the real with the ideal. The keen, individual, fox-like expression of Voltaire is softened by something which makes us love the old atheist because of his love for humanity. We remember, as we look at this seated statue, that he was wont to dole out soup to the poor and hungry from his own doorstep. Another statue that we must make mention of is the charming "Diana," represented entirely nude. The style is pure and graceful; she is represented not at all as a Greek Artemis. The modern French idea of that chaste goddess is much less dignified and nobly beautiful than the one the Greek entertained.

There is a reclining statue of "Byblis, changed into a fountain," by Charles Dupaty (1775–1825), which is lovely in its contour and conceived with true sculpturesque feeling.

The works of the men who have lived into our own time have been preserved, many of them, in the Luxembourg. M. Antoine Louis Barye (1795–1875) is represented by his bronze group of a jaguar devouring a hare. This group was cast by the lost wax method, in one mould; a process that is coming into general use again, and one which was in great favor with the artists of the Italian Renaissance. M. Barye won distinction, especially in the line of animal representation, and was undoubtedly among the first sculptors in the world. His group of a lion devouring a boar, in the Tuileries garden, is known to us all by the small copies of it sent to this country. Barye was a most conscientious and untiring

student of nature. He lacked, however, the necessary ideal qualities and represented literal facts.

Another great sculptor in the present French school is M. Emmanuel Frémiet, born in 1824; he is the author of the famous equestrian statue of Joan of Arc in the Rue de Rivoli. The horse in this group is considered by many animal sculptors to be the finest in existence. All the sculpture by this eminent artist is wrought out with artistic feeling and wonderful technical skill. Another interesting figure in the hall of the Luxembourg is the "Virgil," by M. Thomas, a professor in the École des Beaux Arts. All that this refined sculptor has executed is worthy of our study. His work is more calm perhaps than that of any other Frenchman, and nearer to the Greek spirit. It is always moderate, and its pathos is the pathos of all great art. The work reflects the man's character, honest, simple, thorough, high-minded, and noble. François Rude we know best by his group of the Marseillaise, a vigorous high-relief on the Arc de Triomphe at the head of the Champs Elysées. This group is modeled with tremendous power, but it leaves upon the mind the impression of uncouthness. Another famous statue is the Spartacus, by Foyatier, in the Tuileries. Pradier, who died in 1852, has left good work in his "Fontaine Molière" in the Rue Richelieu. A great man we must not forget is Pierre Jean David, known as David d'Angers (1789–1856), the author of the pediment of the Pantheon, and of the Lafayette at Washington in our own country. This artist combined with great artistic gifts a noble mental endowment and an independent spirit, and like Poussin and Puget, has left the record of an almost stainless life. We may mention names of men who are famous to-day, notably those of Paul Dubois, and the even, refined, and classic Chapu, as well as Guillaume Perraud, Carpeaux, author of the group of dancing girls which adorns the Opera House, Aimé Millet, and Falguire, who has made many "Dianas" which are

Dianas merely in name. This artist is as skilful in the mechanics of sculpture as any man in France, not excepting Rodin. Neither the one nor the other has produced work which is large enough in its conception, and sculpturesque enough in its treatment, to be called great; still in France they are reckoned as the leading sculptors of the day. Our standpoint is different.

The present school of sculpture in France is by far the most important in the modern world. Intimate knowledge of human and animal form is combined with complete technical skill. The sculptors of the Praxitelean age exhibit less technical knowledge than do these clever Frenchmen. At times the French school displays force as original genius: alas, that they should be dominated as they are, and over-ridden in life as well as art, by a debasing, sensual realism! Realism is carried so far that often their statues are nearly exact copies of nude models. French life demands this literal and voluptuous expression. Their sculpture is not monumental and their last effort, called "A Memorial to Gambetta," "out-Herods Herod." It is perfervid to the point of nausea. The sculptor of this clumsy nightmare has not learned one limitation of his art. As a general criticism, one may say French sculpture as well as architecture goes too far. It lacks the quiet restraint that is characteristic of the great schools of Greece and Italy. Their splendid technical qualities and consummate knowledge of anatomy make this lack of idea and moderation more palpable. When the life of France is different we may hope for works of art that are worthy of the clever technique that distinguishes the carvings of her artists.

English Sculpture.—The west front of Wells Cathedral is covered with figures carved early in the thirteenth century, before Niccolò Pisano had cut his wonderful pulpit at Pisa, and many years before the beautiful cathedral of Amiens was built. It is believed that the men who did the interesting work on the cathedral in

England were Englishmen. We are told, moreover, that Edward I caused "stone crosses of magnificent architecture, adorned with statues of the departed queen," to be erected wherever the body of his beloved wife, Eleanor, stopped on its way to Westminster Abbey. A certain William Torell carved the figure of a king for Henry III's tomb in Westminster Abbey, and executed three recumbent statues of Queen Eleanor about the year 1291. These facts are interesting, because they show us how early Englishmen did work in sculpture in their own country.

The cathedrals and churches built in the thirteenth and fourteenth centuries show many examples of carving of a historic or religious character. Over the steps of Henry VII's chapel, upon the arch, are to be seen fifty or more statues. On the north side is a coronation of Henry V; while on the south face is an effigy of the king, fully armed, mounted on his horse and riding with his companions at full speed. Flaxman speaks of this sculpture as being bold and characteristic. Again, in St. Mary's church, Warwick, may still be seen an effigy of Richard Beauchamp. It is a gilt bronze figure on a marble pedestal, praying, and is the work of William Austen of London. About it are other small bronze statues in niches.

Pietro Tourgiemo of Florence, the sculptor who is said to have given Michael Angelo, in a fit of jealousy, the blow that broke his nose, came to London to make the tomb of Henry VII; and it is recorded that he remained there six years. Henry VIII ordered him to make the most magnificent sepulchral monument possible. Some design was prepared, but the monument was never executed. In 1538 Henry VIII made a proclamation that all images which had been worshiped should be taken down from the churches; and during the minority of Edward VI, the Duke of Somerset who, as regent, had assumed the title of Lord Protector, ordered all images without regard to character or meaning to be thrown down.

It was then a dark age for sculpture in England, and no revival occurred until Charles I came to the throne. The first true artist of the English school was Grinling Gibbons (1648–1721), whose wonderful carvings in wood are still to be seen at Windsor Castle, in the choir of St. Paul's, and in other places. The author of the tomb of General Wolfe in Westminster Abbey was Joseph Wilton. He inaugurated a style which, it is said, Flaxman afterward perfected. From 1740 to 1799 lived John Bacon, who made the busts of Dr. Johnson and John Howard in Westminster Abbey. He was a man of no mean ability.

Thomas Banks (1735–1805) is declared by Scott to be the father of ideal sculpture in England. He first studied wood-carving and afterward entered the Royal Academy, where he won the gold medal which entitled him to three years study in Rome. He devoted his time to the study of the antique, which influenced his style not a little. He returned to England, to find but scanty appreciation, and left, disappointed, for Russia, where he remained two years. Catherine II is said to have bought one of his statues and a bas-relief of much merit. A model for a figure of "Achilles Mourning for his Briseis" is preserved in the British Institute. This sculptor of eminent ability had the misfortune to come before the people were ready for him. His life was one of hard disappointments. His enthusiasms were chilled, and his poetic genius was stultified, for lack of sympathy.

Joseph Nollekens (1737–1823) did some mediocre portrait busts, — "pot-boiling" work, which the more highly organized Banks despised; and, while Banks could hardly make a living, Nollekens amassed a great fortune.

John Flaxman (1755–1826), who is said by eminent English critics to have made the English school of this century, learned his art in the shop of his father, who was a maker of plaster casts. The advantage which he enjoyed in boyhood of seeing the reproductions

of whatever sculpture was current, produced its effect in after life. At eleven and a half years of age he gained a prize for modeling, and at fourteen was admitted to the Royal Academy. In 1787 he went to Italy, where he remained seven years under the same influences that had formed the genius of Thorwaldsen and Canova. In Rome and its environs, and about Naples, Greek statues and fragments were being found. An enthusiasm for antique work arose, as it did in the best days of the Italian Renaissance. Antique sculpture had a powerful effect upon Flaxman, and led to the formation of that severe and simple style for which he has been distinguished. His "Shield of Achilles," modeled after the description given by Homer, is a fine piece of work. Among his other famous pieces are an "Apollo" and "St. Michael and Satan," done for the Earl of Egremont, and the frieze for the front of the Covent Garden Theatre. Some of his most charming work is found in the bas-reliefs upon the Wedgwood pottery. He also designed vases of exquisite form. In 1810 he was made Professor of Sculpture at the Royal Academy. Here he gave lectures in art every year during the remainder of his life. His outline designs in illustration of Homer and Dante have been admired by all the world.

Edward H. Bailey (1788–1841) was a noted pupil of Flaxman. He is the author of the "Nelson" on the column in Trafalgar Square. A man who gained name and fame for his portrait sculpture was Sir Francis Chantry (1788–1841). He, like Thomas Banks, began life as a wood-carver. In 1803 he entered the Royal Academy, and in 1809 had won fame for his statue of George III. In 1819 he went to Italy; in 1835 he was knighted. A group by him in Litchfield Cathedral is much admired. A statue of Lady Louisa Russell good critics have called beautiful.

We come now to Sir Richard Westmacott, a pupil of Canova (1775–1856). His works were, for the most part, monumental. He did the monuments to Pitt and Addison in Westminster Abbey, and

to Sir Ralph Abercrombie in St. Paul's. He also executed a bronze statue of George III in Windsor. In 1816 he succeeded Flaxman as Professor of Sculpture.

Richard Westmacott (1799–1872), son of Sir Richard, was scarcely less famous. He was the pupil of his father, and afterwards studied in Italy. He was elected fellow of the Royal Society in 1837, and of the Royal Academy in 1839. In 1857 he became Professor of Sculpture in the Royal Academy. His works are chiefly classical and devotional in their character. His "David," as the slayer of Goliath, and his "Cymbal Player," are noted examples of his work. He achieved distinction also as a writer upon art topics.

John Gibson (1791–1856) was also a pupil of Canova, and afterward of Thorwaldsen. He passed the greater part of his artistic life in Rome. Like many of his predecessors, he studied wood-carving in his youth. In 1817 he went to London as a portrait sculptor, and in the same year, when he was twenty-six years of age, he went to Rome. On his return to England, in 1844, with the statue of Huskisson, he was greeted with the warmest enthusiasm, and was invited to visit Windsor, where he executed a statue of the Queen. His life in Rome was simple and generous, and he was widely known and respected. His only pupil who has achieved distinction is Harriet Hosmer. Some of his famous works are "A Hunter and his Dog," "Narcissus," in the Royal Academy, "Psyche borne by the Zephyrs," now in Rome, and his "Wounded Amazon." Gibson favored the practice of painting statues, an idea which was much opposed by many, and his tinted "Venus" was widely criticised at the time of its execution. There is no doubt that this idea did great harm to sculpture, by creating a desire to add to pure form a meretricious, realistic accessory, the office of which in sculpture was not understood.

John H. Foley (1818–1874) attained considerable reputation for his groups and portraits. He was made an academician in 1858.

Among his famous works are "The Youth at the Stream," "Ino and Bacchus," and "Venus rescuing Æneas."

There are many English sculptors of talent to-day, although the climate and conditions are unfavorable to the highest development of this art. The greater portion of them have been students in France and Italy. These may be mentioned: Patrick McDowell, author of the "Europe" on the Albert memorial; Alfred Stevens, the creator of that wonderful piece of decorative sculpture in St. Paul's, the monument to the Duke of Wellington; John Thomas, who has done some fine sculpture in the new houses of Parliament. Mention should be made of Joseph Edgar Boehm, who, although born at Vienna, has lived and worked chiefly in England. He has been held in high esteem by the royal family, and has executed many works for the government. One of his most interesting statues is that of Carlyle.

Names of sculptors often mentioned to-day are those of Gilbert, Thornycroft, Gebhart, and Onslow Ford.

Russian Sculpture. — The Russians are developing an important school of sculpture. It has the saving grace of originality. Whatever may be said of it, it is not a weak following of French art; vigor and dash characterize all the art efforts of this brilliant people. In depicting animal life they are especially strong. Pio Welonski, now working in Rome, is one of their representative men. Marc Antocalsky, residing in Paris, is a man whose work has a strong individuality. This sculpture of Russia lacks a certain humanizing quality which is essential to a lovely and rounded art. Mention should be made also of Martos, Halborg, Orlovsky, and Tchizhob.

Flemish Sculpture. — In Holland little has been done in the art of sculpture. Nature has provided no ready or suitable materials; no sculptor has arisen to rival in any degree the splendid art of

Rembrandt, the great painter. What statues and monuments we find in the museums, public squares, or halls of Dutch towns, are for the most part the work of foreign artists, so we may pass from Holland to the school of Flanders. It is in the picturesque city of Bruges that we find the best proofs that sculpture was practiced in Flanders contemporaneously with her great art of painting. Two of the most famous works in that city are to be found in the church of Notre Dame; they are the tombs of Charles the Bold and his daughter, Mary of Burgundy. The effigies are in gilt copper, and repose upon black marble slabs. The carving of the drapery and accessories is wonderfully delicate and chaste. They are remarkable chiefly for the fact that they exhibit an execution that could hardly be excelled to-day.

In the Palais de Justice, in the room where the juries are wont to deliberate, is a famous chimney-piece of carved wood, of which a cast is shown in the Louvre in Paris. It is thought to have been executed by Hermann Glosencamp, who, having been condemned to death, asked leave to execute one last example of his handicraft. By profession he was a wood-carver. He produced, with the aid of his daughter, this most wonderful and beautiful mantel-piece, which not only saved his life, but obtained for him a full pardon. The statues which adorn it are of nearly life-size. In the centre Charles V is represented, holding in one hand a sword and in the other a globe. On his right is a statue of his illustrious grandfather, Charles the Bold, and on his left are portrait statues of Mary of Burgundy and Maximilian of Austria. The space between these statues is filled with a variety of ornaments, cupids, spirits, armorial bearings, etc. The work is considered a masterpiece of composition, and is greatly admired for the delicacy and beauty of its workmanship. It is not to be wondered that the sculptor was granted his life.

In the Museum of Dijon, among others, is a work by a Flemish

artist, a tomb of the Dukes of Burgundy, Philip the Hardy, finished in 1404. We know this to be the work of a sculptor named Claux Sluter, who was assisted by his nephew, Claux de Vousonne, and by Jacques de Baerz, all three of whom served the Duke of Burgundy. Between this age and our own time there is little work of sufficient interest to warrant comment. In our own day may be mentioned Geefs, Fiers, Sopers, and Wiener, who have attained eminence in sculpture.

The work upon the tombs to which allusion has been made is as delicate and beautiful in many cases as the work of the early Italian Renaissance.

American Sculpture and Sculptors. — The art of sculpture with us has followed the natural order of development; that is, it has come only after the necessities of life have been provided for, and some time after the love of painting has been developed. Considerable interest has been manifested in architecture, and particularly in that classical phase of it which we have termed colonial. The fact that the material from which sculpture is cut, viz., marble, is expensive, and has to be brought from Italy, accounts partially for the lack of fine sculpture in our country; but it is more easily accounted for by understanding thoroughly the conditions of life which engender and develop a love for pure form. These conditions have not long existed in America. That they do exist in part to-day, has been shown in an article published elsewhere, entitled "An American School of Sculpture."[1] As early as 1784 we have notice of a Mrs. Patience Wright, born at Bordentown, N.J., 1725, who achieved some success at home, and made for herself a reputation in England as a sculptor. She made likenesses in England of the king and queen, Lord Chatham, and others. She died in 1785. A year before her death there is mention of a statue in wax of Lord

[1] *Art for America.* Boston: Roberts Bros.

Chatham, size of life, standing in a glass case in Westminster Abbey. We must admire her and pity her, when we consider the unfortunate accident of her birth, in an atmosphere not tempered to the artistic genius, and the lack of early instruction. We must admire her for having achieved anything under such hard circumstances. When Mr. Adams was minister at the court of St. James, Mrs. Adams described in an interesting way a visit to Mrs. Wright's studio. Her modeling was done, for the most part, in wax.

At this time, we already had famous painters, such men as West, Trumbull, and Stuart, while Mrs. Wright seems to have been the only American who had achieved any reputation in sculpture. The arrival of Houdon in 1785 from France, whom Jefferson and Franklin persuaded to come to this country to make a statue of Washington for the State House at Richmond, marked an era for American lovers of art. The head of Washington was modeled directly from life, at Mount Vernon. Mr. Madison was present at many of the sittings. From this statue, which is still in existence, and the excellent painting of his head by Stuart, we may form a just conception of how Washington looked. These portraits were universally admired in their day. Houdon's cast is common enough in France as well as in America, and is an excellent piece of work, though not as big and magnanimous a representation, nor as satisfactory, from an ideal standpoint, as is that made by our own sculptor, Crawford, the father of F. Marion Crawford, the author. This visit of Houdon had a beneficial effect, in agitating in society a desire to know more of, and to own, good works of sculpture. In 1789 came to America a certain John Dixey, who practiced ornamental stone-cutting and wood-carving. We hear of him as the vice-president of the Pennsylvania Academy of Fine Arts, in 1810 or 1812.

William Rush (born in Philadelphia in 1757, died in 1833) achieved distinction as a modeler and as a wood-carver. The

second foreign sculptor of any importance who visited America was Giuseppe Ceracchi, known in France and England. He had worked with Canova upon the Pantheon in Rome. He arrived in this country in 1791, and did his best to awaken an interest in the fine arts. He was interested with William Rush and others in the plan for the Academy of Fine Arts in Philadelphia. He wished to build a great monument; but Congress failed to appropriate the necessary funds. Before he left this country he executed several interesting busts, notably those of Alexander Hamilton, Washington, Jefferson, Paul Jones, John Jay, and others. When we consider that he was here but four years, the amount of work he accomplished is remarkable; and his portrait busts are cherished with great care, as they have brought down to us the countenances of some of our greatest men. His work smacks of the pseudo-classical school of Canova. His after-history was melancholy. He joined those in France who were interested in the French Revolution, and on a charge of being concerned in a plot against the first Napoleon, he was guillotined in 1801.

In the rotunda of the Capitol is a bas-relief signed by N. Gevelot, 1827. The subject is Penn making his treaty with the Indians. Nothing seems to be known of this sculptor or of his work. Another bas-relief in the rotunda is signed by A. Capellano, 1827. The theme represented is Pocahontas saving Captain Smith. This man seems to have done other work, but of no great artistic value.

In 1790, at Rahway, N.J., was born John Frazee, the first American sculptor who was educated and pursued his art at home. His early years were hard. He had been brought up as a stone-cutter, and in 1820 we have a record of the first statues he ever saw; they were some casts sent by Napoleon to the New York Academy of Fine Arts. A portrait bust of his dead child, made before he had seen any sculpture, procured for him an introduction to the president of the Academy, Trumbull, who had put himself on ignominious

record, as having informed him that "nothing in sculpture would be wanted in this country for a hundred years." No wonder Frazee exclaimed: "Is such a man fit for a president of an academy of fine arts?"

Artistic appreciation in the early part of our century seems to have been a rare thing. We find the clear-headed John Adams writing to a French sculptor who wished to make his portrait in 1818: "The age of sculpture and painting has not yet arrived in this country, and I hope it will be long before it does so. I would not give a sixpence for a picture by Raphael or a statue by Phidias." Still, we find him later inviting this sculptor, M. Binon, to become his guest at Quincy, and consenting to the unpleasant operation of having a plaster mask made of his face, as well as posing for a portrait bust. This bust is to be seen in Faneuil Hall, in Boston, to-day. The first portrait bust made by an American is said to be that of John Wells, Esq., executed, after the death of the subject, by John Frazee, of whom we have spoken. Frazee also made busts of Chief-Justice Marshall, Daniel Webster, Judges Story and Westcott, and of Thomas H. Perkins and John Lowell of Boston.

Names multiply rapidly as we study the history of sculpture after 1825. Horatio Greenough and Hiram Powers, two men who have exercised considerable influence on American art, were born in the same year, 1805. Greenough was a man of scholarly attainments and artistic instincts, and those who knew Powers speak high praise of him. Greenough died in 1852, at the early age of forty-seven. He was a man of undoubted power and untiring energy. To him belongs the credit of being the first American who executed a group in marble, viz., that of "The Chanting Cherubs." The design was suggested to him by Fenimore Cooper, who gave him a commission to execute it. Cooper seems to have had a great love for the Madonna di Foligno by Raphael, in Florence, and the idea of

Greenough's cherubs is distinctly traceable to the cherubim in the foreground of this picture. Henry T. Tuckerman, in the "Book of the Artists," describes this group in a beautiful way. Hiram Powers displayed much mechanical ingenuity as a boy. As a youth, we hear of him as having gained considerable reputation for wax figures he executed for a show, and a panoramic spectacle of the infernal regions, in which the little demons he had modeled were made to act their several parts by skilful mechanical devices. Some of Powers's busts deserve all the reputation the last years have brought to him. He had the true artistic insight and pure classical feeling for art. The adulation bestowed upon him when he executed his "Greek Slave" was far greater than the work merited; still, we may excuse it, when we consider it was one of the first statues by an American sculptor that claimed public attention abroad. His busts are characterized by fine spiritual feeling, and his reputation may rest safely upon the ideal work he achieved in this line.

Joel T. Hart, born in Kentucky in 1810, and for many years a resident of Florence, the author of a statue of Henry Clay in Louisville, has achieved a certain distinction in his art. He invented a clever machine, by which the tedious labor of transferring the model to marble has been considerably lessened. He was a careful student of the human form, and a conscientious workman.

Thomas Crawford, born in New York in 1813, was the first American who had a thorough training in his art from his boyhood. He went to study in Italy while still a youth, where Thorwaldsen, that generous Dane, aided him. Charles Sumner made him famous. He found him in Rome, a poor man, unknown and discouraged. He was instrumental in obtaining for Crawford the commission for the group of "Orpheus seeking Eurydice," now in the Boston Athenæum. It is a group composed by one who, though still young, had a fine poetic feeling for what is sculpturesque. The figure of an Indian chief, part of the group in the pediment of the Capitol

at Washington, was so much admired by the English sculptor Gibson, that he wished it to be cast in bronze, and set up as a monument to Crawford in Rome. Crawford died in 1857, at forty-four years of age, in London. His unfinished work was completed by Randolph Rogers, his friend. A complete set of casts from his work may be seen in the Museum of Fine Arts, in New York. These display the workings of a mind original, vigorous, and artistic. He was a man who must have had in him decided power, or he could not have drawn forth such enthusiastic friendship as Charles Sumner showed him. Had he lived to greater years, he would have achieved enduring distinction. We cannot but lament his untimely death.

Other names we may mention now, are those of Henry Kirke Brown, born at Leyden, Mass., in 1814; Henry Dexter, born in Nelson, Madison County, N. Y., in 1806; and Erastus D. Palmer, born in Pompey, N. Y., 1817. These men, in their work, exhibited industry and talent. They were men who worked faithfully, and whose devotion to art we cannot admire too much or too long.

William Wetmore Story, born in Salem, Mass., 1819, son of Chief-Justice Story, unlike the men who preceded him, had from the first all that wealth, culture, and generous surroundings can give to the development of artistic talent. He was a graduate of Harvard University and, after leaving college, wrote law treatises, as well as poetry that has brought him no little reputation. We do not know whether the future will reckon his poetry to be greater than his efforts in sculpture. His sculpture is conventional rather than imaginatively creative. It is doubtful if the rare word genius will ever be coupled with his name. His work shows culture, study, refinement, and elegance; it lacks spontaneity. He has represented the art of sculpture with dignity.

A name which must not be omitted is that of Thomas Ball, born in Charlestown, Mass., 1819, and still living in Florence, Italy. His

greatest work, undoubtedly, is the equestrian statue of Washington in the Public Garden, Boston. After all criticism has been made upon this statue, it stands there for all time as a complete embodiment, nobly conceived and bravely executed, of our first president. The horse is not executed with the technical cleverness that the great French sculptor Frémiet brings to his work; but it may be doubted if the latter could produce a work as essentially monumental as this. Almost everything that Mr. Ball has done shows a feeling for sculpture, true and lovable. It is better to sacrifice the almost fatal cleverness of perfect technical execution than the all-important essential quality which makes a work monumental. Ball's statue is monumental, or nothing.

Much creditable work has been done in sculpture by J. Q. A. Ward, born in Urbana, Ohio, 1830. Two notable figures by him may be seen in New York City to-day, viz., his "Washington" on Wall Street, and his statue of Shakespeare in Central Park. His work displays sufficient technical ability, while the theme chosen is wrought out in a manner that is dignified, straightforward, simple, and sculpturesque. His equestrian statue of General Thomas, in Washington, has been praised by good judges of the art.

Launt Thompson, although an Irishman by birth, has so identified himself with America, that his name must not be omitted from even these brief biographical notes. His talent is refined and finished, with facile power and true feeling for sculpture.

A name which may be mentioned here, and one better known, perhaps, than any other American sculptor's, is that of John Rogers, born in Salem, Mass. (1829), and living now (1894) in New York City. He has done more than any living American to popularize the art of sculpture among us. When his handiwork became known, cheap casts of the vapid figures of Canova and his school became less common. Some of his groups, especially his war subjects, show decided artistic merit; this is conceded by all sculptors and art critics.

Randolph Rogers, who died in Rome about 1890, was born in New York State in 1825. He pursued his art studies chiefly at Rome, where the greater part of his after life was passed. His best known works are the bronze doors of the Capitol at Washington, which represent scenes, in high relief, from the life of Columbus. A well-known figure of his is the "Nydia," a subject taken from Bulwer's *The Last Days of Pompeii*.

The work of St. Gaudens, French, Warner, and other contemporary sculptors, is so well known, that it need not receive further comment here.

CYCLES OF DEVELOPMENT OF ART.

GREEK SCULPTURE	ITALIAN SCULPTURE
DAEDALEAN	
AEGINETAN	NICCOLÒ PISANO
TRANSITIONAL	DONATELLO
PHIDIAN	MICHAEL ANGELO
PRAXITELEAN	GIOVANNI DA BOLOGNA
DECLINE	BERNINI
DECAY	DECAY

PART II.

THE PRACTICE OF SCULPTURE.

THE STUDIO.

PERHAPS the first and most necessary thing for the successful practice of the art of sculpture is a suitable studio. This need not be elaborate, nor finely finished, but must possess certain indispensable features. It may be in a loft or outbuilding or unused stable. It should be upon the ground floor if possible, and so arranged that it may be readily warmed in winter if the climate be severe. This is necessary, not only for the comfort of the sculptor, but to keep his clay models from freezing; for clay once frozen crumbles to pieces, and the figure is ruined.

Light. — It is important, also, that the light in a sculptor's studio should be well arranged. The light should come from the north, or as near that point of the compass as possible, because it is desirable to obtain as much daylight as one can without sunshine. The reason for this is, that a bust or statue which stands where sunlight may be thrown or reflected upon it becomes less simple. There are distinct lights or shadows, whereas the same statue in a cool light is seen more sharply and distinctly. The lights and shadows are simple, and the view is not confused by reflected light thrown into the shadow. All light should, if possible, be admitted

from above. When a side-light only is possible, the lower half of the window should be curtained, so that the light may fall down upon the object as it does in nature. In any case, the light should come from one direction only. If the light be admitted from the side, the model must be moved frequently, so that the light shall fall on all sides equally, otherwise the likeness will be perceptible only in one particular light, or from one point of view. It is well to have a studio so arranged that the light may be admitted from different directions if required, so that the model may be seen in various lights, and defects thus detected that might otherwise be overlooked. These various lights should be kept carefully curtained except when required to test the correctness of the work accomplished. When one works by night, the light should be so arranged as to fall upon the front of the work. Many sculptors when working upon equestrian statues or monumental work remove their models into the open air, in order more correctly to judge of the progress of the work. This can most easily be accomplished by the use of tracks. To do this frequently is of great assistance to the sculptor; he is able to judge how the work will appear when set up in its proper position, under the real light of the sky; for the light of the studio, at its best, is defective.

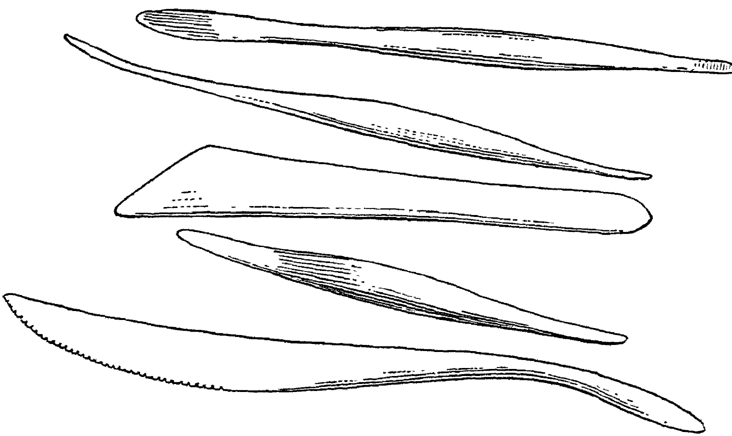
As a rule, the smaller the aperture through which the light is admitted to the studio, the more direct and pronounced are the shadows, and the more clear and distinct is every detail. It will be found convenient, therefore, to have suitable curtains arranged before the studio light, so that it may be easily regulated.

If the light be admitted from above, the skylight should be placed at an angle of not more than 45 degrees — better less.

Construction. — The studio should, if possible, be constructed of wood, and the interior should be left unfinished. Mechanical appliances, which may be necessary in the progress of the work, may

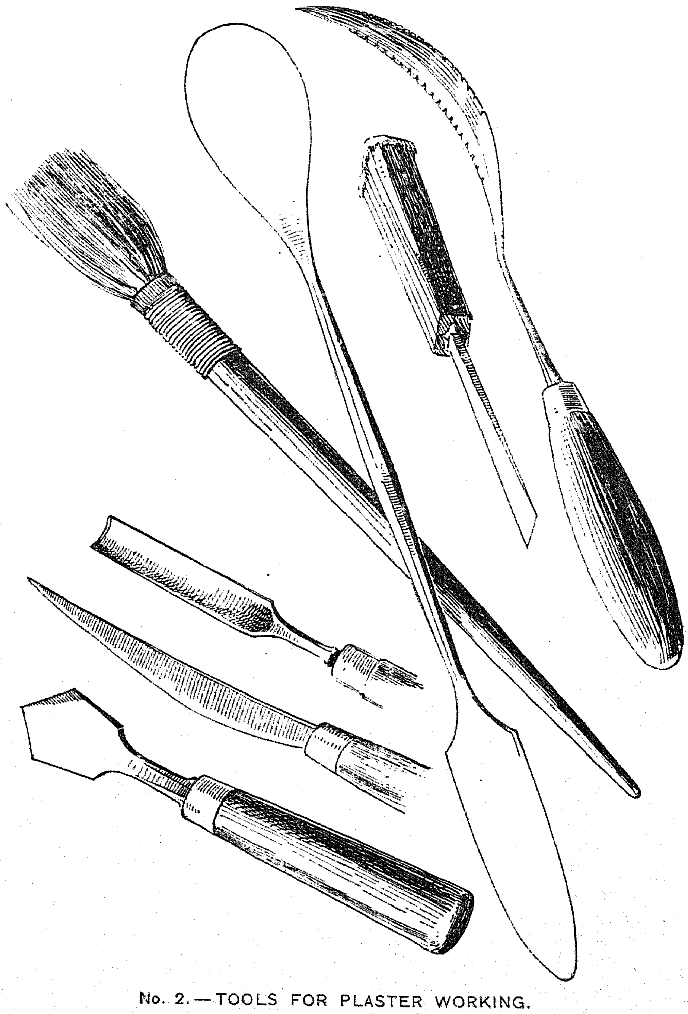
thus be readily attached to the walls if required, and as readily removed. The floor should be well laid, level, and firmly supported. It should be of a material which a thorough wetting will not injure, for in the progress of large work the studio must be frequently washed. The walls should be colored in a neutral tint; terra cottas and grays are most frequently used for this purpose. Care should be taken, in the construction of a studio, to arrange for a door of sufficient size to permit the ready removal of large models and the admission of necessary materials.

Tools. — The sculptor should provide himself with an abundant supply of tools of two classes: first, those peculiar to his work; and, secondly, a good assortment of carpenter's tools. The latter will



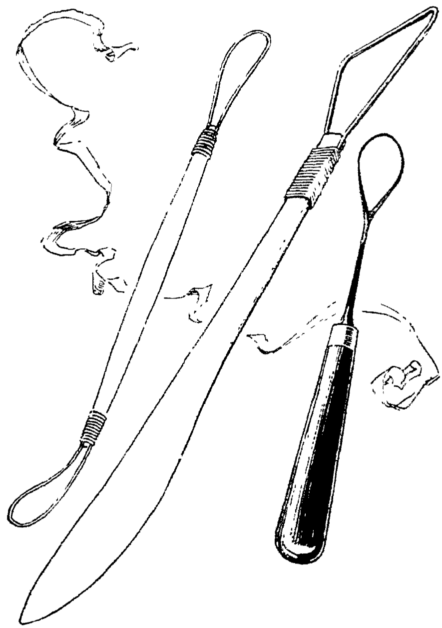
No. 1 — TOOLS FOR MODELING IN CLAY OR WAX.

be found useful, and, indeed, indispensable in construction of skeletons, frames, and other appliances, which will be described hereafter. The tools belonging directly to the sculptor's work are well displayed in the accompanying cuts. Experience has shown these designs



No. 2.—TOOLS FOR PLASTER WORKING.

to be best adapted to the work. It is understood, as a matter of course, here that all sculpture is first modeled in clay or wax, and not cut directly, as some suppose, from stone and marble. Hence the tools here shown are those for use in clay or wax modeling. Those employed in stone-cutting will be discussed



No 3.—TOOLS FOR CLAY-WORK.

under that head. The best tools are made of polished box-wood or rubber, as seen in the cuts. A twisted wire of brass or iron enters into the partial constructions of some varieties. The French school makes use of some tools constructed wholly of steel or iron, with serrated edge.

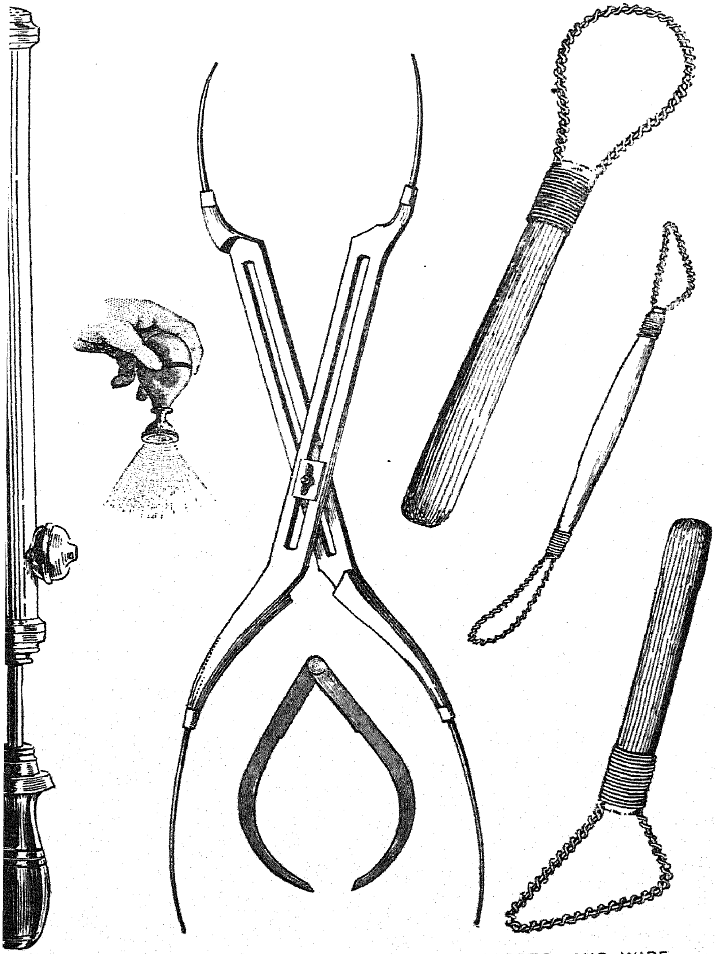
Tools are generally of three kinds, and are to be used only when the work is too fine for the fingers.

1. Tools with chisel edge, either square or oblique.
2. Tools with a convex edge or point.
3. Tools with a concave edge.

Excellent tools are made from cocoa-nut wood. The close surface prevents clay from adhering, and the feeling in the hand is one of pleasure. Tools are usually from 6 to 10 inches in length, and swell toward the middle, which should be oval, so that the tool may be held firmly, and conveniently turned at will between the thumb and the first two fingers. To make these tools, saw the wood into desired shape, then rasp the tool into form with wood-rasp; next, smooth with a scraper or the edge of a piece of broken glass; finish with fine sand-paper, and finally polish by burnishing with a smooth convex steel instrument.

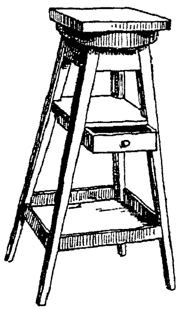
One eminent sculptor has shown that tools are made to use on the parts of a statue or bust only where the fingers cannot be used. A good tool resembles a finger, and is capable of similar and perhaps more delicate work. Each sculptor must find the tools best suited to his own handling. Any well equipped art-store can furnish ordinary tools (see cut No. 1). It is advisable for sculptors to make their own, and many actually do so, since they are simple and easily made. One soon learns from his work the tools best adapted to his hand, and makes them from material near at hand.

Studio Appliances. — The first requisite is one or more good modeling-stands. The construction of these is extremely simple, but must be such as to secure stability rather than elegance. Although some are constructed with three legs, those with four are to be preferred, since the former are too easily overturned. The top should be so arranged as to turn easily upon its rollers or pivot, and thus allow the clay model to be readily turned in any direction.



No. 4.—PUMPS FOR MOISTENING CLAY, COMPASSES, AND WIRE TOOLS FOR MODELING.

The top should overlap the lower part so that the water may not come in contact with rollers or other mechanism and thus by rusting impede their ready action. The construction of the modeling-stand in most common use may be seen in cut No. 5. To prevent warping, the top should be made of two sections, the grain of the lower section set at right angles with that of the upper, and the two sections then firmly fastened together. It is convenient to have a modeling-stand that may be raised and lowered at will; but these are expensive and more complex in design. The ordinary stand can be made by any carpenter or cabinet-maker at a small expense. Hard and thoroughly seasoned wood is desirable. It is a great convenience to have the stand mounted upon rollers, so that it may easily be moved about. In case of large or monumental work, the stand should be placed upon heavy rollers, as in frontispiece, or on a track. In small modeling-stands the top should turn easily upon a pivot let into a socket.



No. 5. — MODELING-STAND.

A number of boxes of varying sizes, strongly constructed, will be found indispensable for the studio. Small holes should be cut in the sides and top, to provide for the insertion of fingers, so that the boxes may be easily moved. A wet sponge is convenient for occasionally cleansing the fingers from accumulated clay. This is necessary since, from the natural heat of the skin, the adhering clay quickly dries and crumbles over the work.

Modeling. — Clay and wax are most easily manipulated. Stone and wood require more time and tools in the working, beside taking greater strength and facility. After one has learned to work in wax or clay, one is better prepared, if the growth has been normal, to carve and cut these less flexible materials.

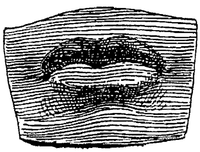
Modeling should be undertaken before drawing, and is as useful to the painter almost as to the sculptor. We have evidences of crude attempts to carve and model in prehistoric times, before man had learned to draw. In the great industrial schools abroad, and now in our own country, modeling is made the basis of all instruction. By modeling one learns unconsciously to draw. Any one with patience and perseverance may learn to copy simple forms. Experience and skill make the successful modeler. This is the mechanical or technical side of sculpture. One, however, may master its every difficulty and yet not be a great sculptor.

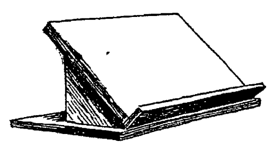

No. 6.—KNEADING THE CLAY.

The mechanical process of modeling is as follows: Having secured the clay from the nearest pottery or art-shop, we proceed to make it ready for use. If it be hard and broken in pieces it must be put in a tub or suitable receptacle and sprinkled with clean water. Leave it to soak and stir it from time to time, so that it may be moistened evenly throughout. Let us start, however, with the hypothesis that you have obtained soft clay, pliable and ready for immediate use. Even in such a case it will be well to work it thoroughly, as one kneads dough in making bread (see cut No. 6), so that every part may respond to your touch. It should be soft as velvet, and all sand and foreign matter should be carefully removed.

Pass your hand through and through it. If it is too dry for easy manipulation, add more water; if too wet and sticky, add more clay, or work with the hands until it is of right consistency. In any case, a good kneading will do it no harm. It is the first lesson in modeling—to knead one's own clay and thus accustom the fingers to its use.

Let your first subject be neither too large nor too small, not difficult nor intricate. Beginners should not attempt anything original. A cast of a strong face with many lines, like that of Dante, or a cast of the eyes or mouth of Michael Angelo's David, would be good for the beginner. Place the subject on a flat board, or, better, attach it to a board constructed for work in relief, and set it at an angle, as shown in cut No. 8. Drive one or two nails into the background, to which attach pieces of copper wire of varying lengths, to the end of which fasten short pieces of wood, made to support the clay. Such supports are called "butterflies." These should be well made. Now, press the clay upon the board and let your wire of "butterflies" rest inside, where they will do the most service as supports. Do not attempt to shape any part in your hand, but put the clay upon the board and squeeze it into the general form of the whole mask or subject to be copied, and so gradually build up until it seems to be of like proportion with the model. Look now to the contour of the whole. Do not become fascinated with, and attempt to finish, any one part; keep all at the same state of advancement, otherwise, in attending to some detail, you will find that the proportion of the whole has been sacrificed. This is a vital law: attend to mass first, then detail will come naturally. One may make occasional use of calipers or


No. 7.—A STUDY.


No. 8—BOARD FOR RELIEF WORK

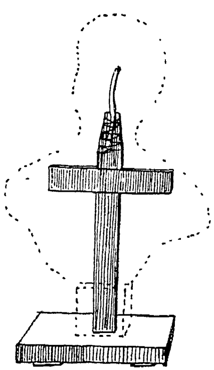
compasses, made as shown in cut No. 4. It is well to keep in mind, however, what Michael Angelo said, viz.: "that a sculptor's compasses should be in his eyes." Train the eye to be its own compasses, lest your work look mechanical. Begin at once to look at your work, as it grows, from a distance. Do not stand over it continuously, walk away every few moments; this is a thing one must make a habit from the beginning. It is the general effect that you are concerned with chiefly; this is vastly more important than fine finish.

The first simple work being finished, a second and more difficult model may be undertaken, such as a mask of St. Jerome by Michael Angelo, or the head of the "Venus of Melos." Be sure to take some worthy subject, so that taste and eye may be cultivated from the first. Some trouble will be found in the beginning in treating hair. Avoid attempting to model every hair. Represent your hair by masses or tufts, not by fine lines, for such give a hard, wooden effect. It is the soft, wavy quality that we care for in sculpture—the *movement* of the hair. The Venus should be taken after the St. Jerome, for the subtle curves of a woman's rounded cheek, or those of a child, are the most difficult things to do in all sculpture. An old head is much more easily copied than a young one. Do not try to improve upon a model. Copy it as literally and neatly as possible.

We may now undertake a bust; let us take, for example, the head of one of the Roman emperors with strongly marked features. The head of the "Young Augustus" can be obtained as easily as any other. Now we must see how best to support the clay. It has not consistency to stand of itself, and we must construct a frame-work or skeleton which will hold the clay firmly and safely. We place a flat piece of board, say six inches square, upon the top of the stand, and into this we mortise an upright, or prop, which is to run up through the centre of the bust and head. It should come within

about an inch of the top of the head. It is a desirable way to make the prop run as high as the neck and then to attach to it firmly with copper wire a strong piece of lead pipe, say ¾ inch in diameter (see cut No. 9). As the lead pipe may be readily bent, this will admit of turning the head in any direction. The action is the first thing to be considered, — the pose or inclination. Do not use string in construction, as it soon rots and smells badly.

A little reading of the general principles of phrenology may now be done with advantage. Learn the salient characteristics of the human head. Camper and Rimmer are excellent authorities. The clay must be firmly pressed about the prop or support and upon the cross-pieces shown in cut No. 9, intended to support the shoulders. This cross-piece must be firmly attached with wire or screws to the prop running up through the bust. In modeling a bust, turn the work frequently and move all about it. Do not develop one side of the head farther than the other. Look at the general contour of the whole. Block or square out the work first. Learn to see the planes in the face and head. Remember that this process of modeling is quite the reverse of chiseling. In carving, one takes a block of stone and chips away what is not needed, until the size and shape correspond with the model or original design. In modeling in clay, we start with a support of wood or iron and build up until the desired height or relief is attained. One should add pellet by pellet, rolling a piece of clay in the fingers into balls, and adjusting with the thumb or tool to the body of the clay. See that each pellet or piece becomes an integral part of the body or nucleus of clay, and firmly welded to it. Eyelids, parts of lips and ears, and other delicate portions are



No. 9. — SKELETON FOR BUST

formed by rolling clay in the fingers to the desired size, and then applying the roll or string of clay where it is called for and adjusting the same carefully with a tool suited to the purpose.

Learn to look at your work not only from a distance, but step on a ladder and look down upon it; get down upon your knees and look up at it. In other words, look at it from every direction possible. Every change will reveal new defects, if there be any. You cannot look at it from too many directions, be assured of that. At first you will find your compasses valuable aids. Establish certain vital proportions, such as the distance between the eyes, height of face, length of nose, etc. Learn to do without them as your eye becomes trained. Learn from the first to use a plumb-line; a ball of clay fastened to the end of a slight string will answer. Hold this in front of the model; notice the position of the face and its parts with regard to the plumb or vertical in the model; then see if your copy has the same relations when you hold your line in front of it. See if the action corresponds with the action of the model. Leave this work from time to time, being sure to cover it with wet cloths or a rubber cloth, so as to insure its being kept moist and pliable. Sprinkle it night and morning (see Frontispiece). Vary your work with simple designs of foliage, or some decorative, architectural design (see cuts Nos. 10 and 11). The latter teaches precision. because exactness is required. Keep the copy and model on the same level, and as close as convenient to one another.

A hand or foot may now be undertaken. A peg of wood, or large nails set or driven in a board, will form sufficient support for the clay in such simple subjects. Do not try anything original until you can make successful copies of other work. After making such, try a simple head from nature. Find an old man or woman with strongly marked features, who will pose for you. Proceed in modeling from nature as you have done in working from casts.

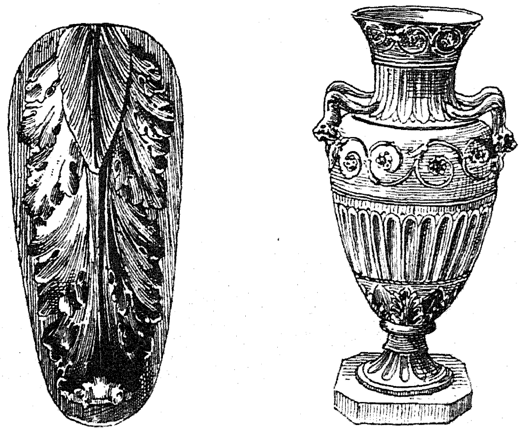
We come now to the building of a figure of life or colossal size. For sketches, use copper wire for the skeleton; twist one strand upon another, as shown in the design (cut No. 12); attach pieces of copper wire for arms, legs, etc. Any design not over a foot in height may be built upon wire, as skeleton shown in the cut. A design not over six inches in height is often made without a skeleton, having the interior simply of clay, a little harder than that used upon large

No. 10 — SUBJECTS FOR DECORATIVE MODELING.

work. In building wire-skeletons, take careful account of the length of the arms and legs, so that the wire may not protrude when the clay is put upon it. Have a canon of proportion, such as that given in Fau and Rimmer.

The building up of a large figure has many difficulties. The following method is employed in most studios. If the sculptor is to build a large figure, he makes first a small sketch model, say, from two to four feet in height. He perfects this model, until it expresses

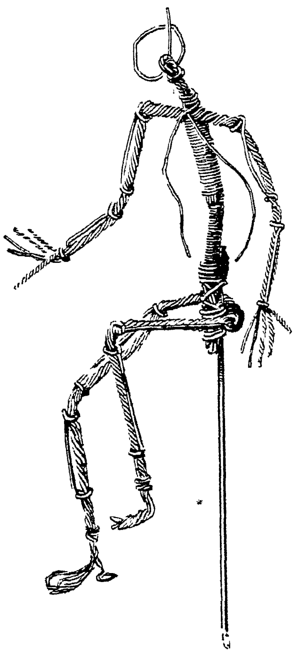
the meaning he wishes to convey — until the action, pose, contour, and expression are satisfactory. It should be built with careful regard to proportion. If the sculptor's figure is to be of colossal size, eight feet in height, for example, a small model may be made, two feet in height, that is one fourth, or four feet, which is half; then, when he comes to construct his large figure, he can, by his enlarging calipers, throw up the colossal statue by a simple mathe-



No. 11. — SUBJECTS FOR DECORATIVE MODELING.

matical process. It is hardly necessary to say that this sketch-model should be studied first from the nude living model, and then clothed in the costume or drapery of the epoch represented. Too much care cannot be bestowed upon this sketch-model; carelessness or hurry at this stage of the work will surely lead to serious trouble and great waste of time, money, etc., later. The art of sculpture requires great conscientiousness; let every step of the work be done thoroughly. A flimsy construction has ruined many a noble statue.

The Skeleton. — Having a modeling-stand well constructed, and, for the sake of convenience, set upon rollers, so as to be readily moved to or from the light, as the sculptor may wish, we proceed to construct the frame-work or skeleton destined to support the clay. The common method, which is in vogue in many great studios, is to get a bar of iron and to bend it into the general shape required. This iron should have four feet or claws at the bottom, which may be securely screwed into the modeling-stand, or board, or platform nailed upon it, which is to support the statue. This iron, as will be seen, runs up a foot or more in the rear of the proposed statue, then is turned directly forward, at a right angle, so as to enter the back of the statue at the dorsal vertebrae. Then it bends at another right angle and passes up through the torso as far as the nape of the neck. To this iron are fixed cross-pieces of very thick lead pipe or wrought iron. These are to support the weight of the clay at the hips and shoulders, and to these in turn must be attached the lead pipe or irons which are to form the skeleton of the legs and arms. It is readily understood that the iron or pipe in the legs must be left long enough to descend through the middle of the ankle and through the six inches of clay which is generally left under a statue, to the groundwork of boards, and there, where action has been determined upon, they are firmly fixed with nails. "Butterflies" must be attached to the skeleton of


No. 12 — SKELETON FOR FULL FIGURE.

the legs and arms and to the central support of iron. Make use of plenty of these, else you may enter your studio some fine morning and find your wet clay upon the floor. Most sculptors have had this sad experience.

In constructing the support for the head, attach a strong piece of lead pipe to the central core. This will pass through the neck and almost to the top of the head, and will admit of the head being turned in any direction. Make use of small square pieces of wood about the size of a carpenter's lead pencil to strengthen parts of legs and arms where there is no joint. These should be bound about the part to be strengthened; they are found very useful in helping to sustain the clay that is apt to slide away from the limbs. The iron used for the support or core one may call the central iron or backbone. It must vary, of course, in size, according to the size of the statue and the weight of the clay it is to sustain. For an eight foot statue, an iron three inches square, or at least two inches and a half, will be found none too large.

Having prepared, then, our skeleton, we may proceed to the covering of it with clay. The clay should be tightly pressed about the core, which passes through the torso first; then model roughly the limbs, neck, and head. The suggestions given for modeling a bust apply as well to an entire figure, and need hardly be repeated. Make use now of a garden syringe or pump, as shown in cut No. 4, for wetting your figure. If the studio be warmed, this should be done frequently. Throw but a little water upon it at a time, not enough to run; a little stream working its way into the clay will cause a crack and result often in an entire section falling off.

We must speak of the framework of the hands; this should be made of twisted copper wire, in rough imitation of the actual skeleton. The fingers should be so constructed as to be moved in any direction.

We have now given sufficient directions for the construction of the ground-work or skeleton which may serve for any ordinary single figure. Much must, of necessity, be left to the natural ingenuity of the student. Every sculptor has his own methods and ways of constructing supports for his figures. Cut No. 13 shows a sculptor in the act of putting clay upon a large figure. Cut No. 12 again has shown the skeleton of this figure before any clay had been applied to it. The use of certain large tools, as shown in cuts, will be found of great assistance. In all large work use a thin piece of copper wire for cutting clay. Wherever it is necessary to attach drapery to a figure, wire netting of a very coarse mesh will be found useful. Fasten this with long wooden pegs to the body. In this way it is easily and firmly supported.

Now a word as to keeping the clay in working condition. It is not enough to sprinkle it night and morning; it should be covered at night with damp cloths. These cloths should be of very light weight; a thin muslin, such as is used in covering butter, is the most desirable. It will be found convenient and advisable to construct a square framework, which may be suspended over your figure. Attach to this a rubber cloth which shall fall on all sides and over the top, and so excluding the air, keep your clay figure moist and in good condition. This framework may be let up and down by pulley and rope. Most well-equipped studios have one or more of these. If one has no syringe or sprinkler at hand, a small whisk broom may be used to wet the clay.

In throwing up the large figure from the sketch-model, begin at first by taking only the principal measurements, such as height, breadth of shoulders, position of chin, nipples, navel, thigh bone, patella, etc. Your large figure at this stage should be studied from the nude model, and the muscular forms roughly blocked out, no matter if they are to be entirely covered with the costume. Select for this purpose a model with an exaggerated muscular development,

No. 13.—SCULPTOR AT WORK UPON CLAY MODEL.

or your statue, when completed and covered with its drapery, will look thin and lifeless. As you establish different points of measurement, or proportion, from the little model (of which it is advisable to have a nude study), by means of your enlarging compasses, put in small wooden pegs, — they come of a wedge-like shape, about an inch and a quarter long, the top end of the thickness of a lead pencil, and tapering to a point. From the moment you begin to put your clay upon the skeleton, make constant use of the plumb-line.

Proportions of the Figure. — Proportion is the true relation of one part to another, and should produce on the mind the effect of a harmonious whole. It may be defined simply as harmonious relation or symmetry.

Even the nymphs, satyrs, centaurs, and other creations of the Greek fancy were produced according to strict laws of proportion. With the decadence of Greek art artistic proportions were lost sight of. In the tenth century the crude sculptors of the new religious art produced figures varying from four or five heads to fourteen heads in length; there seems to have been no established canon. In the middle ages little thought was given to harmonious proportion. The sculptor thought only of the fervid, religious idea or symbol he wished to embody. The ugly seems to have been thought an effective way of representing a religious idea.

Toward the end of the fourteenth century, at the time when the Belvedere torso was discovered, and many other antique sculptures unearthed, may be noted a return to the old laws and principles governing proportion and construction; and finally Michael Angelo accepted and restored the Greek standard of Vitruvius. Each statue should be distinct, individual, and harmonious in itself.

If you put a long head on a square body, or a square head on a long body, the appearance is incongruous and disproportionate; no sense of harmony is produced. But if you place a long head

on a long body, or a square head on a square body, the result is harmonious.

The difference in the height of people is the difference in the length of the leg. A number of people seated together will appear of about the same height.

In this book we shall hold to the system of proportion formulated by Vitruvius, which he deduced from the writings of the most eminent Greek sculptors, and which Michael Angelo adopted. He gives us this general rule, viz.: that the ancients made their figures eight heads or ten faces high; and that all other subdivisions of the body were based upon this standard. He takes the head as the unit. The common divisions in length of the human figure are as follows:

Total height of figure, eight heads (that is, skull-lengths). The average male head is 8¾ inches; this would make a figure of 5 feet 10 inches. For artistic purposes it is well to make the figure 6 feet high. From the os pubis (or pubic bone) to the sole of the foot, one half; from the os pubis to the top of the head, one half. The os pubis should always be the centre of the total length of the entire figure. Flaxman gives the three following divisions, viz.: first, from acromion process (the upper process of the shoulder-blade articulating with the collar-bone) to the front termination of the pelvis; second, from there to the top of the patella or knee-cap; third, from the top of the patella to the bottom of the inner ankle.

To lend added grace, the Greeks added an inch or two of length to the lower limbs in excess of the length of the torso. The legs may be made more graceful by increasing the length from the patella to the sole of the foot. The dignity and grace of a figure depend largely upon the length of the lower limbs.

The average foot-length, 11 inches. Two foot-lengths are allowed for the length of the leg from the ground to top of the patella.

The Arm. — From acromion process to elbow (in straight arm), 1½ heads. From elbow to first knuckles, 1½ heads. As a general rule, from acromion process to elbow is the same distance as from the elbow to the first knuckle. The hand is the same length as face, or ¾ of a head.

Breadths. — Shoulders between the two acromion processes, 2 heads. Across the loins or edge of pelvis, 1¼ heads. Across hips or trochanter (one of the two processes at the upper end of thigh-bone), 1½ heads.

Depths. — Shoulders from pectoral to shoulder-blade, 1⅛ heads. Loins, rim of pelvis, ¾ head from front to back termination. Gluteus, 1 head.

Proportions of the Female. — The proportions of woman are in the lengths the same as those of man, viz.: the whole figure is 8 heads in length. The average female head measures eight and one fourth (8¼) inches from the bottom of the chin to the apex of the skull. This gives us, then, a figure 5 feet 6 inches in height. If the lower limbs are equal to the length of the torso, this would be the average size of a woman. The Venus de Medici is 5 feet and 3 inches in height. The head measures 7½ inches in length. The centre of the whole figure is the os pubis, or front termination of the lower part of the pelvis. The width of shoulders, 2 heads; width of hips or trochanters, 1¾ heads.

Length of Arm in Female. — From acromion process to elbow, 1½ heads. From elbow to first knuckles, 1½ heads. Length of foot, 1⅛ heads. Length of leg, 2¼ heads.

A proportion common to both sexes is this, viz.: the outstretched arms, measured from tip to tip of fingers, will give the same length

as the total height of the figure. From the pit of the throat to the nipple of the breast, 8¼ inches, or one head-length, and the same from nipple to nipple. The difference in the proportions of the male and female skeleton is in the widths. The bones in the female are of greater delicacy and lightness. The collar-bones sloping, seem to lengthen the neck. As these proportions fell into disuse after the time of Phidias, Praxiteles, and their immediate followers, art began to retrograde.

Expression. — Expression has been called the soul of art. It may be best described, perhaps, as that characteristic or attribute which distinguishes one individual from another. For example, a friend is coming toward you from a distant point; he is too far away for you to see his face or the details of his clothing, yet you recognize him at once by a peculiar gait, inclination, or attitude. It is this distinguishing trait with which the artist is vitally concerned. Great artists receive and give forth this characteristic of "expression" in a large and dramatic way, while inferior artists seldom rise above the theatrical rendering of it. The study of the sketches of Michael Angelo will lead to an appreciation of this great quality better than many books written upon the subject. (Bear in mind, however, that his chief defect sprang from too fervid expression.) With a few sweeping lines he gives the entire character of his model. Expression is obtained by looking at a thing in its great curves.

One man, for instance, drops his shoulders and head in a peculiar way; you know him at once from any of his townsmen; another has a long, ambling gait. As men depart from the normal, the more are they easily represented in art; that is, the lowest and easiest form of art is caricature. Expression, while a vital quality, is not sufficient of itself; and where it has become all-important, the decadence of art has quickly followed. See, for example, the debased school of Bernini and his followers.

Expression may be said to belong as much to the mental and sensuous make-up of the artist as to the purely technical side of his art. Genuine feeling will do more to make art impressive than any possible or strained expression. This is shown in the work of the early masters. The pure and simple forms used by Donatello and the Della Robbias are certainly more impressive and characteristic of a greater art than the work of Bernini and his school, which has already been referred to. If one lacks this quality, it is most easily obtained, perhaps, by attendance at any well-ordered theatre, especially such a theatre as the French have, where comedy and character-depiction is the chief aim.

Harmony. — For a fine sense of harmony no nation has ever equalled the Greek. Let us take, for example, the statues of Antinous or the Adonis of the Naples Museum, typical embodiments of perfected youthful grace and rhythm. The large forms in these statues are given with a calm firmness that would make them charming and restful if only fragments were left to us. Let us look, on the other hand, at the fighting gladiator of the Louvre. Study the balance and proportion of the whole. Every muscle is brought into proportionate use; one side is not developed at the expense of the other. It is consistent and harmonious throughout, though not of the best period.

Two distinct types are given in two female figures of antiquity, viz., the Venus of Melos and the Venus de Medici. Both measure eight heads in length; the one is calm, majestic dignity; the other, soft, winning grace. Utterly different, yet each is harmonious in itself.

Composition. — Composition is largely a mental operation; for, until the hand has been trained to execute, thought is of little avail. It comes naturally after invention. It may be considered under two

heads: first, as it pleases the eye, by happy and proper disposition of light and shade; and, secondly, as it gives more adequate expression to the theme, by preserving a correspondence between the sentiment of the subject and the material employed. In all cases the object and ultimate aim of composition is to develop the sentiment or poetic feeling which it is desired to express. It is the echo of the sense, as much as sound is in the writing of poetry. It is an all-important consideration. The Greek had mastered its laws completely. Given an architectural space to decorate, he filled it so adequately as to leave nothing further to be desired. Neither can anything be taken away without taking away from the meaning it is intended to convey. The greatest composer of modern times, perhaps, is Michael Angelo. No more felicitous arrangement can be suggested, perhaps, than that of the ceiling of the Sistine Chapel.

Drapery. — After considering the nude figure, its sentiment, character, and expression, after having determined upon our action, and developed the different muscular forms and superficial anatomy, we come, naturally, to consider the drapery or costume with which we are to clothe it.

The lines of the drapery should be contrasted with or opposed to those of the figure, and in other cases should be parallel to the latter. All this fine and sagacious choosing belongs partly to the artist's instinct for selection, and as much, perhaps, to the education he has received and the antique models he has studied. Let us look at the principles, or laws, which govern the curves and folds which drapery takes on. We must consider, too, the difference between heavy and light drapery.

Drapery, then, like other things about us, is subject to the laws of gravitation and motion; and is affected more or less by these laws according to its weight or airiness, its strength or weakness of texture, the force of wind or other power moving it, — according,

of course, to the action or lack of action in the wearer. This study of drapery is very intricate; it will either add to or take from the force of character of your statue; and it must add to or take from its poetic meaning. It is not an accessory, but a vital part of your figure. The Greeks achieved preëminent distinction in the treatment of drapery. No artists before or after can be compared to them, except, perhaps, the masters of the Italian Renaissance. The Greek used drapery to make his figures terrible, mystical, or sublimely beautiful. Study a cast of the statue of the "Nike of Samothrace," or "Winged Victory"; see what added motion is given to the figure by the way in which the drapery is thrown back.

The most common and simple forms of drapery are those produced by the weight of the cloth hanging straight down from two projecting points of a surface or figure. These forms we call folds, and a succession or series of such folds lends dignity, height, and massive strength to the figure. See, for example, what nobility such straight folds have given to the archaic Greek statues. Such folds can be used with good effect when opposed to the soft curves of the arms or shoulders.

One of the first facts we must consider in drapery is its uniformity. It may be thick throughout, or light and easily agitated; but it should be uniform throughout, for all artistic purposes. If it is not so, we can make no laws for its action, and shall have to trust the clothing of our figures to haphazard. Let us assume, then, that whatever quality or weight our drapery possesses, we may depend on its being uniform. Naturally, the heavier the material, the broader and more generous are its folds; while, if the drapery be thin and flexible, the number of folds is greatly multiplied; and this idea is more marked where the drapery is suspended from the figure; for the light weight of the stuff enables the model to take up easily a great quantity, and to throw it over the shoulder, or to gather it in

drooping folds over the girdle, or to fasten it easily with a pin or brooch. Textures that feel soft in the hand assume naturally soft and pleasing curves, while harsh or heavy material is apt to take on folds that are sharp, cross cut, and angular in character.

If we throw a piece of drapery carelessly over any object, it rests, naturally, on the most salient points of such object, and it will fall either perpendicularly as the folds we have previously described, or it will be caught up and hung in waves or festoons. If the drapery is very heavy, it will hang in folds that radiate from the point of attachment. All folds radiate from the points of support, or from the points or places where they are gathered and held up, according to the fashion or necessity of the time. These facts regarding thickness or lightness, harshness or softness, abundance or meagreness of drapery, together with this law of radiation from points of support, are the facts or basis upon which we construct draperies.

Where two points of support are equally distant from the ground, and of equal prominence, it is easy to see that drapery will fall in symmetrical waves between them; but where one is more prominent, the folds will meet alternately and give greater sharpness and variety to the composition. Where much drapery hangs from one point, it will drop straight down; but the central line of the whole mass, it will be seen, is the only one which is actually perpendicular.

So much for drapery hanging from points or supports. Where drapery falls loosely over the figure, a general direction or inclination is given to its folds by a drawing of it, or pulling toward some other part of the body by action or change of motion. In cases like this the laws that govern it are as manifold as the actions which the human body may assume, or the causes which may affect it. Such cases must be studied always from nature. Mr. Moody, formerly of South Kensington, gives a general rule that "folds will be shaken out from the front and upper parts of the body or limbs, and will be naturally found where there is more room for them; for we should

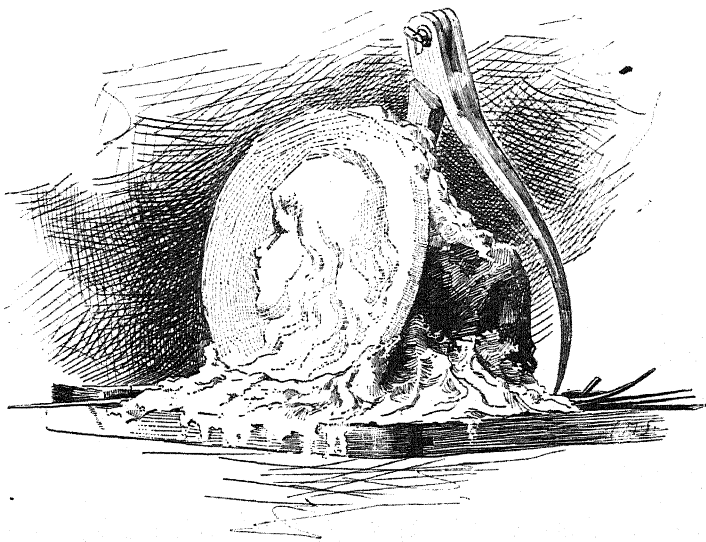
never forget that depth is necessary to folds. Where this ceases to be the case, the drapery must either be plain or in flat plaits." The same critic shows, in his excellent lectures, how color, variety, motion, and mass are given to the figure by a proper use of drapery; and how necessary it is to art and to plastic and pictorial interpretations of history and the social distinctions imposed by society. The king is known from the beggar by the character of his drapery. Perhaps he exaggerates its importance; for it is certain that the nude figure in the hand of the Greek and modern artist has been made inexpressibly lovely; still it is so valuable an adjunct, and so much a part of man, that we must understand how to handle it, and have full appreciation of the dignity of its office.

Modeling in Relief. — In the modeling of reliefs one usually places a layer of clay upon a slab of slate or square drawing-board, varying in size according to the requirements of the work. Clay must be put on of depth sufficient for the intended relief, — little for low relief, like the work of Donatello, a great deal for such work as the Della Robbias did. Many modern sculptors draw an outline upon their slab of slate, then fill it in with clay to the thickness desired, thus keeping the work true to one plane. This is the common, and, one may add, commonplace, manner of modeling bas relief. Men who have studied this subject in an exhaustive way believe that the true and artistic way of modeling in relief is as follows:

The background should be of clay, and no part of the relief should be made higher than the background. One advantage, ostensibly, of this order of relief is that the spectator can see the work only from the right position, viz., the front. We are speaking more particularly in this respect of low and middle relief, and not of high relief. Most relief is meant to be lighted from one side, but seen from the front. Work in relief may be called a compromise between drawing and modeling. To be successful in this order of sculpture

requires true artistic feeling, and great knowledge of the laws and limitations of sculpture.

Egyptian and Assyrian reliefs are particularly interesting, and are usually found to have been cut out of, and not attached to, the background. A comparison of modern work with that of Greece, or even of Egypt and Assyria, will show that the sculptors among



No. 14.—PORTRAIT RELIEF IN MARBLE, READY FOR FINISHER.

even these ancient people understood work in relief, or the technique of relief, better than most modern artists. The variety given by the uneven and waving background of antique work accounts largely for its charm and its vital force. In what work we have of Greece, scarcely an instance can be cited where the background is the level plane so much used to-day. The background should vary according

to the feeling the sculptor wishes to express. There are occasions when we must cut below the average surface, and sometimes, to obtain an effect, the background must rise to give the desired shadow over form or feature.

It is easier, of course, to make high or alto relief than to execute low relief. It is readily seen that striking effects are at once obtained in high relief. Less subtlety of genius is required for this kind of work. The method practiced by certain medieval sculptors — of modeling in low relief, then raising the whole design, and cutting a groove about the outline — should not be copied. It partakes too much of artifice to be called legitimate. Serious men will avoid it. The student should take great care to see that the light falls upon his work from only one direction. It may be either a top or a side light. Modeling in relief is a branch of sculpture that cannot be taught. It comes largely from poetic feeling and instinct for the subtle and illusive forms or ideas. The study of Greek models, however, will be of great benefit.

Modeling of Decorative Work. — In the modeling of small objects, such as fruits, flowers, or parts of foliage, the clay to be used may be placed upon a slab of slate, so that the work when completed may be easily removed from the background. It is found convenient often to place under the subject a block or rectangle of clay of an inch or more in thickness, which may be taken hold of and turned in the hand. This permits reaching readily every part of the work. Delicate portions, such as stems of flowers and fruit, are made by rolling bits of clay between the fingers. The petals of flowers are often modeled independently, and adjusted to their places with a small wooden tool. If the subject is not to be taken from the background, artistic and delicate effects may be obtained by cutting below the surface of it, or drawing the subtle portions of the design upon it with a delicate tool.

If the work is designed for terra-cotta, care should be taken that no air-holes are anywhere left. Wed each part firmly to the body of the work, or to the ground to be decorated.

Modeling of Plaques, Vases, etc. — This order of modeling is not difficult, but requires considerable practice to produce successful results. In decorating a vase, choose one that is slightly dry, and a day or two after it has come from the potter's wheel. It is often convenient to do such work at the pottery, or to have in one's studio a potter's wheel. By choosing clay slightly dry, sufficient firmness is given to resist the pressure of the tool or hand when decorating the same. It will be found interesting to use clays of different color. Pleasing results in color are thus obtained.

Architectural Designing. — Architectural decoration opens out a vast field for the modeler. The process is the same as that described under the head of "Modeling of Decorative Work." Such designs are always baked, and become terra-cotta. This material is as durable as, and will resist fire better than, any stone. A special clay is used for this purpose, made up of a combination of potter's clay, fire clay, alkalies, and ground potsherds. The mixing of the whole produces a harmonious substance, which, under the action of fire, vitrifies, and does not require glazing afterward. When baked, this composition is proof against the ravages of time as well as of fire.

The decoration of brick buildings, which is now coming in vogue, as well as the interior ornamentation of fire-places, gives a wide field for development of this order of modeling.

Terra-Cotta Work.— Reference has been made to the preparation of work intended to be baked or fired. If the model be a statue, bust, or other work, care must be taken that space is left in the

body, limbs, or head for air to circulate freely, so that the work may dry equally in all parts. When the clay has become slightly dry, parts may be removed with a fine copper wire and the necessary hollowing made. Then the parts may be replaced. The work should not be taken to the pottery until the clay has dried as thoroughly as is possible without the direct action of fire. The ancients used terra-cotta, or baked clay, not only for statuettes and figurines, such as those of Tanagra, but, moreover, for life-size and colossal statues. There are statues of Jupiter and Juno of full life-size in the museum at Naples in this material. To-day, terra-cotta is used mainly for decorative purposes, and to preserve a sculptor's first small sketch of a proposed work.

Mould-Making and Casting. — After having finished a work in clay, no matter what it be, the artist must put it in some more durable form or material. The material which is most used is called plaster of Paris or calcined gypsum. This process of "casting" may, with patience, be learned by any one; it is entirely mechanical. To do it nicely requires no little experience, however. You ought to begin with some small and simple subject — take, for instance, the mask of Dante, to which we have previously referred. Place your clay copy of it upon a horizontal stand, and build about it a border or wall of clay of, say, a half inch in thickness and an inch in height; this is to keep the liquid plaster from running away. If the model from which you are to cast be of plaster instead of clay, or of any hard material, the process is much more complicated; we shall describe such processes further on. For the present, we shall assume your model to be of clay. Plaster will not adhere to soft clay; so if our mask of Dante be of clay and in good condition, you may mix your plaster and proceed at once to make the mould, which is the first step. Take a common tin basin or bowl, holding, let us say, two quarts and a half, and pour into it two quarts of water. Now,

having procured your plaster of Paris (it is usually sold at paint-shops), sprinkle it into the water, shaking it all about lightly until the plaster seems to have almost filled the dish and absorbed the water. Stir the whole mixture now with a large spoon until the consistency be perfectly smooth and like thick milk or cream. See that the plaster does not form into lumps or balls; stir underneath the surface, so that air be not introduced; now pour or put with the spoon some of the new-made mixture upon your clay model, and be sure that the liquid fills all the recesses of the model. It is well sometimes to blow the liquid plaster into the eyes, ears, and other intricate places which otherwise it might not reach. Now pour your plaster on quite fearlessly until it shall have covered your model to the thickness, let us say, of an inch of the plaster (an experienced caster would make his mould thinner). In about fifteen minutes your plaster will have "set" sufficiently for you to take away the border of clay, and in half an hour more you may turn over the solid mass and dig out the clay model. This should be done carefully, so as not to injure the underlying mould. Remove the clay from the intricate recesses with a small wooden modeling-tool; clean your mould thoroughly with a soft paint brush, and set it aside to dry for some hours. This process of drying may be hastened by placing the mould near the fire.

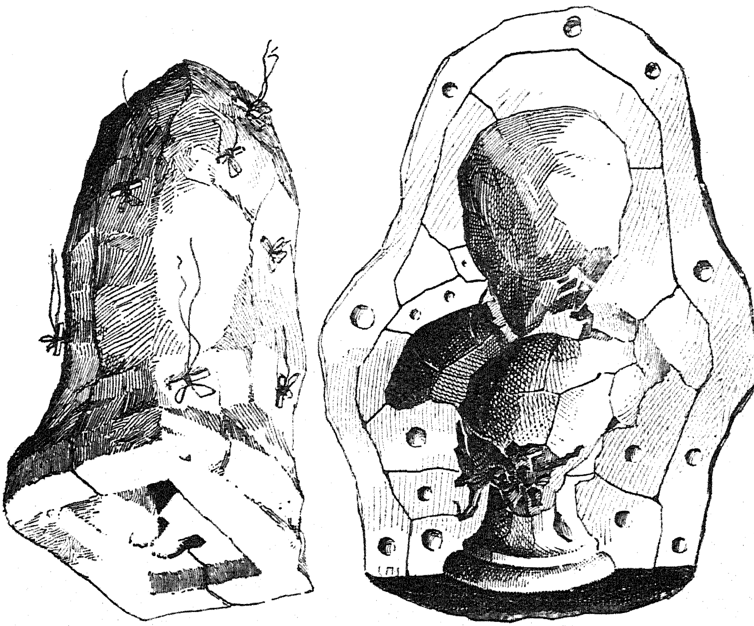
When the mould is found to be thoroughly dry, give the inside two coats or more of linseed oil or shellac varnish, put on carefully with a clean brush; fasten the mould, face down, by setting blocks of wood or broken brick about it to support it; then, having mixed your plaster as above described, pour it into the mould, and see that it penetrates into every crevice and fills the entire space. Let the plaster set for an hour; then turn the mass over and begin to chip away and destroy the mould; use for this purpose a dull chisel of about half an inch in width, and a light wooden mallet. Be careful that you do not injure the underlying cast. When this breaking

away has been accomplished, your cast is complete, and it should be a fac-simile of your clay model. While your plaster is yet soft in the mould, it is well to insert at the top of the face a twisted loop of copper wire, bent at the ends, by which the cast, when complete, may be suspended.

In casting a bust or statue from the clay, one half is first covered with the liquid plaster, which is allowed to "set" before the other half is covered. The two halves are kept from uniting by a solution of clay water or oil painted upon the edges. By this means the mould may be divided and the clay model more readily removed. In casting large statues, a projecting leg or arm is often removed and cast separately.

The kind of mould we have described is called a waste mould to differentiate it from what is known as a piece mould. We may now give our attention to casting in piece moulds. A reference to cut No. 15 will show you such moulds. In the same cut you will see the half of such a mould. No student should attempt to make a piece mould of any work of value until he has watched the operation successfully executed by the hands of experienced mould-makers. Piece moulds are almost never made from clay originals. The original should be in plaster, marble, or bronze. If you wish to undertake the work, you must begin by thoroughly soaping the original, so that plaster will not adhere to it. Now mix in a quart bowl as much plaster as is thought necessary for the piece to be taken, and apply it to the original wherever it is found best to begin the work. A little experience soon teaches that plaster parts may be taken off only from smooth or rounded surfaces, and where no undercuts (or underlying crevices) exist. In the casting of an eye it may be necessary to make several different pieces; when one piece has hardened, trim its edges smoothly and pass around them a coat of shellac, clay water, or any liquid which will prevent the fresh plaster from adhering to said part. More plaster must now be mixed, and the

adjacent surface covered, allowing plaster to form close up to the finished piece; then a third piece must be made, and so on until the whole model or original is covered. Over these little pieces pass a coating of shellac; pour on a large covering of soft plaster, and allow this to set. You will understand this covering best from a



No. 15.—"PIECE MOULD," SHOWING INTERIOR.

reference to cut No. 15, which shows it about the small pieces, holding them firmly in place. This casing or cover the Italians aptly call the mother-mould, which keeps the small pieces, or little children, together. Holes are bored in the top surface of this, as shown in cut No. 15, which are known as keys, and which allow the other half

of the piece mould when completed to be safely and readily attached to it, thus forming the whole piece mould. In the cut you will see depicted, on the exterior surface of the piece mould, wooden pegs held in place firmly by pieces of string. These are made to hold in place such underlying pieces as would fall out when the mould is moved about. It is believed that the cuts will explain this process of making piece moulds better than any words can possibly do. Such moulds, when completed, are shellacked and partially filled with liquid plaster, having been securely fastened together with rope, and when this has set, are taken apart. This mould may serve for many castings, while a waste mould serves but for one example. Cut No. 16 represents a workman engaged in putting together the various parts of a piece mould.

We may now consider a third process of casting, invented within the last twenty years, and known as gelatine casting. Let us take, once more, a plaster cast of the bust known as "The Young Augustus." We cover this head with tissue paper to prevent soiling, and over this we lay a coating or casing of soft clay, say half an inch in thickness. The gelatine ultimately is to fill the place occupied by this clay. Let us now make a simple mould of two pieces over this clay coating; while the plaster is still soft, divide the mould by a piece of strong carpet thread passed around the entire bust over the shoulder and across the topmost ridge of the ears. When this is set we remove the two halves, take out our clay casing, remove the paper from the model, and, having given the latter a coat of shellac, if it be of plaster, place it again within this new-made mould. It will be held in place by keys, or points of plaster, which have been left for this especial purpose. We see now that there is a hollow space about the bust between it and the outer mould. We now prepare our glue or gelatine. Peter Cooper's white glue may be used as well as fine gelatine. This must be boiled and liquefied in what is termed a milk-boiler. When it is soft we may pour it into

the space left for it about the model. Let it harden over night; then carefully separate the halves of the mould. This will leave a casing of gelatine about the model, which can be removed only by cutting it in halves. Now remove the model, and replace the halves of the gelatine mould within the corresponding halves of the plaster shell. Now reunite the whole, and the mould is finished and ready for use.

No. 16. — PUTTING TOGETHER A PIECE MOULD.

Small objects are cast of solid plaster, but busts and larger objects are cast hollow. This last is done to insure lightness, strength, and economy. The hollow casting is effected by pouring a small quantity only of the liquid plaster into the mould at one time, and by maintaining a constant rolling of the mould, so that the plaster shall cover all portions of the interior equally. One entire coating of the interior of the mould must be completed before the plaster begins

to "set." The other coatings may be added at will. Rods of iron are often inserted in the legs or arms of statues to insure strength. In the casting of reliefs a layer of burlap or of flax is often inserted to insure lightness, as well as to hold the material firmly together.

Press Moulds. — There is still another kind of mould sometimes used, which we may call, for want of a better name, a press mould. Such moulds are used where it is intended to reproduce a work of art, or where many copies of the same model are desired. If one, for instance, has made a relief, with no undercuts, in casting the same it will be seen that the mould of plaster of Paris, made over it, can be removed without any injury to the model. This mould, then, may be used to multiply any number of copies like the original, and this is done by simply pressing the clay into the mould, beginning from the centre, let us say, and working out toward the edges, putting every fresh pat of clay upon the starting-point in the centre, and thus making the under-clay cover the entire surface of the mould and leave no cracks or joinings, which would occur if clay were put on at different points and worked together.

The little statuettes, so common in Europe, made of terra-cotta, are reproduced in this way. The clay having been pressed into piece moulds, it will be found useful and interesting to take, let us say, some mould of a little head in low relief, and having made a press of it in clay, to change the entire expression by jarring the clay impression from the bottom or side. With one head as a basis, almost every conceivable expression and shape may be obtained; then, too, a press mould is useful, because it often saves labor. Having a good normal head as a basis, we may readily change the relation of one part to another, and so make the portrait of any subject in a short space of time.

Tinting of Plaster. — It may be well to make brief mention of the methods commonly used for tinting casts in plaster of Paris,

and obtaining some surface that will admit of their being readily cleansed: for, unless such surface is added, it is difficult to freshen a plaster cast when once soiled. The surface known to sculptors and plaster-cast manufacturers as the "ivory finish" is produced as follows: The subject to be coated is placed near a fire and warmed; then ordinary stearin (from which cheap candles are made) is melted, and if the subject is small enough, it is either immersed in a bath of this liquid stearin, being done very quickly, or else the model is held over the bath (having been warmed), and the stearin poured over it quickly from a bowl. The coating thus obtained is hard and shiny.

Good effects are often produced by mixing a little yellow ochre or burnt umber with oil, or turpentine, or even water (we speak of dry colors), and rubbing it over the entire surface; then the high lights are cleaned up with a soft piece of flannel, and the color left in the places where it is desired for artistic effect.

Another way in vogue among sculptors, more than with the plaster-cast manufacturers, is to dissolve common beeswax in turpentine, making a thick mass, and then to re-dissolve a part of this compound (according as the coating of the cast is too light or heavy) in other turpentine, and apply with a soft brush to the cast. Color may be added to this finish if desired.

Yet another way is to paint the surface of the cast with a solution of white lead and linseed oil, very thinly mixed. Any of these surfaces may be cleansed with a little tepid water. Many casters obtain a simple surface by coating the subject with linseed oil or soap.

The tinting of marble we shall consider under the head of Polychromy. It may be suggested here that nothing is so fine as the pure white plaster, provided a suitable light may be found for the cast. Color is useful to counteract the effect of cross-lights. When small pieces, such as statuettes and reliefs, are to be produced and tinted, it is best to use the fine grade of plaster known as alabaster plaster.

The best tinting of casts and coloring in imitation of antique and renaissance work in this country is undoubtedly that done by Mr. Charles Hazeltine of Providence, R. I.

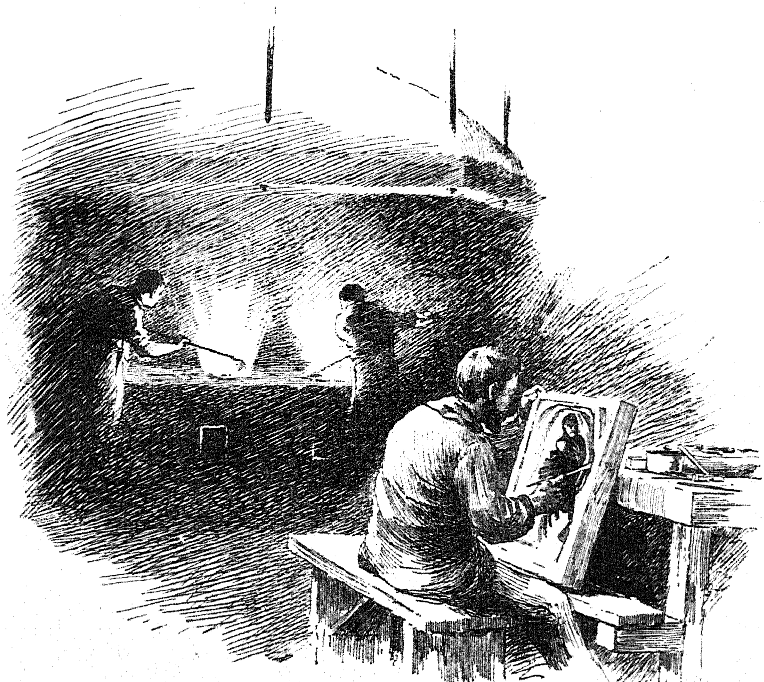
The most complete plaster cast shop in the world is that of P. P. Caproni & Bro., Province Court, Boston. It is well worth a visit, for here one can see every variety of work in progress.

Casting in Bronze. — Bronze casting dates from that period known to archaeologists as the Bronze Age, a prehistoric time lying between the age of stone and that of iron. The brass spoken of in the Bible is probably another term for bronze. The working of iron and steel seems to have been little known or used by the ancients: their armor, weapons, and utensils were usually made of bronze.

Bronze is an alloy of copper, with eight or ten per cent of tin, to which ingredients a little lead and zinc are often added to render the melted mass more fluid and fusible, so that it may fill and flow into all the intricacies of the mould. (See cut No. 17, representing the fusing process in bronze casting.)

Copper is more easily fused by the addition of tin as an alloy. If it is desired to produce a bronze of a very hard and durable nature, the compound is made up of about seven parts copper to one part tin. If, on the other hand, a soft bronze is sought for, to be rolled or worked, the compound is made up of sixteen parts copper to one part of tin. Eighty parts of copper to twenty parts of tin is a common compound for statues and reliefs. From the introduction of metals into the compound, a variety of bronze has been obtained, varying in hardness and color. The method of fusion also affects results. Gold, silver, copper, and lead, and a fusion of lead and tin (producing pewter), besides tin, have been used as alloys in modern as well as ancient times. The alloy chiefly used by the ancients was made up of copper and tin. Those that have been tested are said to contain from ten to thirteen per cent of tin; the

proportion of tin used to-day is less. In the making of bronze, various nations have used different proportions. The bronze of the Greeks had lead, silver, and gold often added to the composition, and the Romans, in their day, adopted the Greek system of pro-



No. 17. — BRONZE CASTING — FUSING THE METAL AND PREPARING THE MOULD.

portion. To-day bronze is composed most frequently of two thirds copper and one third brass, to which ingredients are added, sometimes, small quantities of lead and zinc. The latter metals tend to make the cast more firm and brilliant.

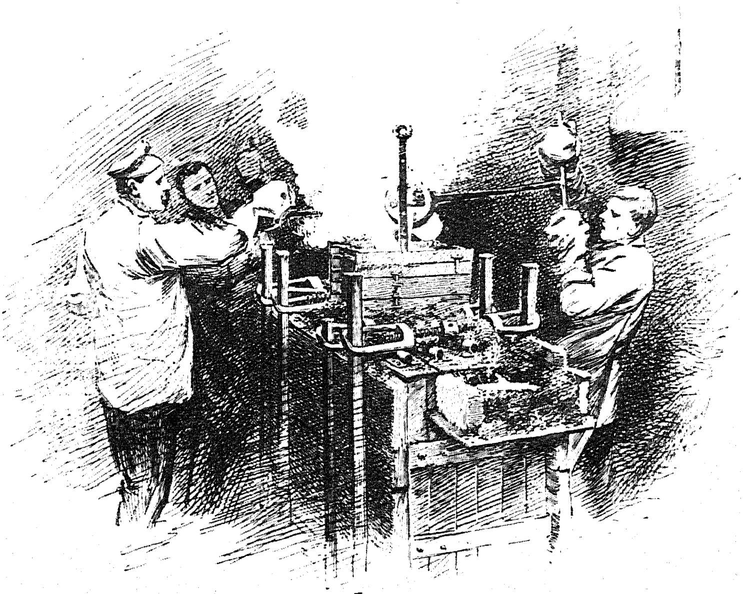
With the ancients bronze casting was carried to a high state of perfection. The Egyptians, Greeks, and Romans made use of it not only for statues, but in the architectural decorations of their temples, palaces, and gorgeous theatres. The wealth of certain ancient cities was gauged by the number of bronze statues they possessed. The bronze of Corinth, Delos, and Egina is famous in history, while Athens, Rhodes, and Delphi are reported to have owned upwards of three thousand statues each.

Casting in bronze is a difficult process, and requires great experience as well as sagacious judgment; for good work a thoroughly equipped workshop is necessary. It is the delicacy and refinement of the workmanship, rather than the color, that distinguishes fine bronzes. All bronze comes from the fire with a brassy tone or color. The patina or color desired is given afterwards by suitable oxidation or sulphurization. Black, red, brown, or green can be easily attained. The color itself has nothing to do with the cost of bronze. It is the labor expended upon its production.

Bronze is cast in two ways, viz., the common way of sand-casting, or the process known as the "Cire Perdue," or "Lost Wax" method, which found favor with the masters of the Italian Renaissance, and has lately come into vogue once more. The method of casting in sand may be described as follows:

A model of the subject to be cast is taken in plaster of Paris. Over this model is made a mould of fine sand, called caen-sand, according to processes described under "Piece Moulds." This sand, while wet, is beaten into the desired firmness with small hammers, and under this hammering process it becomes as hard as stone. When the mould, then, is thus firmly made or formed, the model or core is removed, and the mould filled with the liquefied metal. It is to be understood that the mould, before it has been finally fastened together, has been perforated by a number of channels, to admit of the liquid metal being poured readily into it, and being

allowed to escape easily when the mould has become full. Cut No. 17 shows the men at work preparing the liquid metal, while cut No. 18 shows the metal in a perfectly liquid state being poured from an earthenware vase into the mould which is prepared to receive it. When the metal has cooled, the external casing or mould is taken off, and the metal retains the rough surface of the sand in



No. 18.—BRONZE CASTING—FILLING THE MOULD.

which it has chilled. It can be seen that the reproduction secured by this method of casting must be an exact fac-simile of the model. Over the rough surface, when bronze comes from the mould, is passed a graving-tool, or chisel, to give a desired polish or remove marks or "jets" left by the mould.

Sometimes the whole design is engraved or chiseled without any previous casting. When this is the case, the metal has been given its form by a process of hammering or beating, and is called beaten or wrought work. When iron or bronze is to be beaten the metal must be hot; but in the case of gold, silver, and softer metals, it is hammered or worked cold upon an anvil.

The "Cire Perdue" is a process dear to every true sculptor; because by it bronze is made to reproduce the exact model and touch of the sculptor's hand, without the least after-chiseling or polishing. It is used chiefly to-day for the reproduction of statuettes and busts. It has its dangers and drawbacks. Notwithstanding these, some of the more daring artists of to-day are using this method for the reproduction of important monuments. One of its chief advantages is, that when the model has been transferred to wax, from which the cast is made, the sculptor may enter the foundry and retouch his work at the last moment. The "Lost Wax" method may be described as follows:

When the thickness of the bronze statue or work has been decided upon, wax is run into the space between the core and the mould which the bronze is finally to occupy. The core and mould are made of baked clay, the mould and core being held apart by stays of iron wire. The melted bronze is run in upon the wax, which disappears before the advancing bronze, and runs out of exits prepared. Thus the space occupied by the model, which, we have seen, was made of wax, is now taken up by the bronze, which must be, if successfully cast, an exact reproduction of the original of the model.

Large or monumental works are sometimes cast in one piece, but oftener in parts, which are afterwards united by heating and application of melted metal.

Bronze, as has been already mentioned, is given its color, or "patina," after it has been cast. The green bronze color is sometimes produced on metal by the application of vinegar, or dilute

nitric acid, or sal ammoniac. To give the color of an antique bronze to new-made work in bronze or brass, ¾ of an ounce of sal ammoniac and a drachm and a half of bin-oxalate of potash (salt of sorrel) is dissolved in a quart of vinegar, and this solution rubbed over the bright metal until the surface becomes dry through the friction. The object should be kept warm, and the process repeated until the desired tone or color is found.

Almost any color may be imparted to copper, brass, or iron by an application of chloride of platinum, varying according to the number of applications and degree of dilution. For the bronzing of reliefs, medals, or coins, two parts of verdigris and one part of sal ammoniac are dissolved in vinegar, and the solution then boiled, skimmed, and diluted with water until it produces in the mouth a weak metallic taste, and, on further dilution, lets fall no precipitate. This solution, in turn, is boiled briskly and poured over the subject to be colored.

An occasional rubbing with oil will preserve and restore a fine bronze surface. For the cleansing of bronze statues, a diluted solution of caustic alkalies is used.

Cutting in Marble. — Modern sculptors do little work upon the marble with their own hands, which fact, in a measure, accounts for the characterless result of many finished statues, when compared with a clay model. The great sculptors have chosen at all times to finish their own work, or to direct it with closest scrutiny. Only so may favorable results be obtained. It is said that Michael Angelo carved his entire statues with his own hand. Very few sculptors now believe this. There is so much dull, mechanical work that the machine and "scarpolino" do better than the intellect, that such carving would be a waste of time. Then, too, "the hand of little practice hath the daintier sense," and the continuous striking upon the marble dulls the delicate sense of touch and feeling, and stiffens

the muscles. A sculptor who does all his marble work himself will finally do but little that is fine in modeling and cutting, and, from the tediousness, produce little work, all his time going to the developing of one production. A sculptor should certainly know how. The best carver or marble cutter is the man who is most faithful to your model and idea, and who has no creative genius of his own. The carving of net-work or any delicate design, often so much admired, is merely a labor of patience, and requires no more genius than do the broad and simple surfaces.

No matter what the statue is to be, the sculptor usually models a small sketch in clay or wax. When satisfied that his idea and action are fitted for plastic representation, and he has developed his little model to express that idea, he then sets up his iron skeleton or framework which is to support and form the core of his large work, whatever it may be. This and the following processes have already been fully described. Let us assume that the work is already cast in plaster of Paris, and ready for the firmer material of marble. The model to be copied is placed on a large block, called a "scale-stone." Having secured a block of marble of sufficient size, the operator places this also on a similar block. The most salient parts of the plaster model are marked with a lead pencil. These marks are to serve as points of measurement. The fronts of the "scale-stones" now receive marks that exactly correspond with these. An instrument known as a "pointing machine" is then brought into use. This is constructed with a simple cross as its main feature, and provided with socket joints, and arms that move readily upon them. At the extremity of one arm is affixed a "needle," which is so adjusted as to slide in and out easily, and yet is firmly held when desired. This "pointing machine" is then taken in hand by the carver, or pointer, and adjusted to three salient points of the model, which have been prepared to receive it. (See cut No. 19.) The movable arm is then adjusted to the first point of measurement, such as, for example, the

No. 19.—THE "POINTER" AT WORK.

end of the nose. The "needle" is extended until it touches the pencil mark at this point. The whole instrument is now removed from the model and applied to the block of marble, upon which three corresponding salient points have been marked. It fits into these as it did upon the model. We find, however, that the "needle" does not reach the same depth as it did upon the model. The operator therefore removes his machine, and chisels as much of the marble away as he deems safe. Then he places the machine for a second trial. This process is repeated until the "needle" reaches the required depth. A pencil mark is then made to show that the point is found. In cutting away the operator is careful not to reach the extreme point desired, but to leave a slight surface of perhaps the thickness of a piece of paper. This, in the final finishing, is removed with the chisel or rasp. (For marble tools see cut No. 20.)

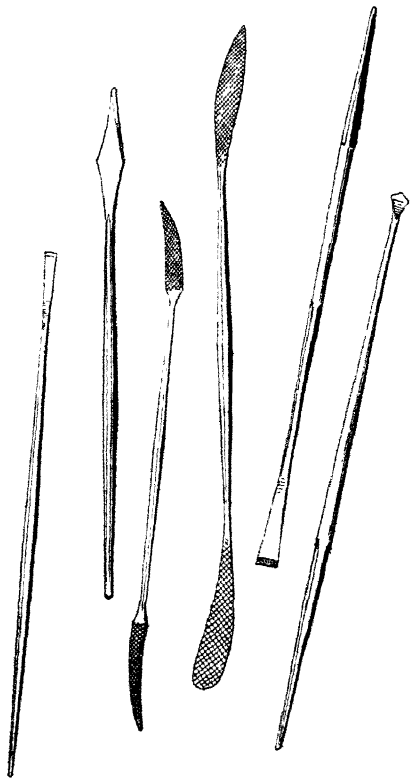
This process is continued until the work to be reproduced is shaped out. A superior workman is now employed, who, with chisel, rasp, and file, copies and develops the more delicate portions of the work. This part of the work is done under the direct supervision of the sculptor himself. Variety of texture and the harmonizing of the whole is finally done by the sculptor's own hand. (See cut No. 21.)

A rich quality of surface is produced by rubbing with fine sand, pumice-stone, or some similar substance. Michael Angelo polished some of his statues, as did many of the ancients. The sharp points of reflected light, however, take from the fine effect of the form. A solution of tea, hot wax, or oils of peculiar quality are often used in producing a mellow tint upon the surface of the marble. This process is quite distinct from Polychromy, or the coloring of sculpture.

Polychromy.— In ancient Egypt statues were colored for religious purposes. It was intended to make them look as nearly like the original as possible, and so deceive the spirit, or Ka, should he

return to the tomb and find that his mummy had been removed. With the Greek, color was used for decorative purposes, or was an accident of the material used. In architecture it enhanced the splendor of the whole, and was a foil to the figures in the frieze. In the middle ages color was often used, and all interior sculpture was colored.

The coloring of parts of a statue destroy the unity and harmony of the whole. Place sculpture in its appropriate and native light, and color will be unnecessary. One may accept as a principle, that any detail of execution that draws our attention from the consideration of a statue as a whole, is bad art. The plastic sense is confused thereby, no matter how we may open our eyes in wonder. If it can be shown that color was in vogue in the best days of Greek art, there is no reason for it that has yet been shown other than private caprice. The coloring of the great "Minerva" and "Jupiter" was, in a measure, accidental, that is, color was the attribute of the precious material of which these colossal statues were constructed. Phidias used these materials because it was



No 20.—TOOLS USED IN MARBLE CUTTING.

required of him to do so. If the effect was strikingly magnificent, it was at the expense of grander emotions. The Greek evidently first took color, with his idea of form, from Egypt. There color, as before indicated, had a religious significance. The Greek continued, somehow, to use it as an ornament when its symbolical force had entirely disappeared. No doubt, in decorative sculpture color has a place, but it should be used only by a master who can distinguish the picturesque from the sculpturesque.

Models. — One seldom finds perfect proportion in the models of to-day. The right side is apt to be more developed than the left, in the bones as well as the muscles. The development in both sexes depends, of course, largely upon the occupation pursued. An all-round athlete is the finest type of physical development to be found. Many good models may be seen in the modern circus. The best models that can be found to-day are men who, starting with good health, have taken sufficient exercise to develop a sound and symmetrical body, and have at the same time rounded out the moral and intellectual sides of their natures. A perfectly developed man should be rounded out physically, morally, and intellectually. It is difficult to find models with the lower extremities of sufficient length. In fact, the artist's power of selection must be brought constantly into play. One model will have finely developed legs, but thin and scrawny arms, and vice versa; another with a splendid torso has a short and insufficient neck, and so on. In the female model the most common defects are: an unequal distribution of fat over the lower part of the figure, perhaps a thin and bony chest, or a too broad pelvis. The sculptor must create his ideal figure from a number of models, selecting with great care a perfect part from each, and combining all parts into a harmonious and organic whole.

No. 21.—THE CARVER OR FINISHER AT WORK.

Art Study Abroad. — The École des Beaux Arts holds examinations twice a year, in February and July. Any American is eligible. The candidate is examined in History, Perspective, Anatomy, Architecture, Drawing, and Modeling. Those who do not reach a certain standard are not admitted. For the examination in history, a list of questions is prepared which may be obtained from the secretary of the school a month before the examination takes place. This list consists of not more than thirty-five questions. Answers may be written in English if candidate prefers that tongue.

In Perspective, some simple problem is given. In Anatomy, the drawing of one or two bones of the human body is required, such as the femur and the knee-joint. In Architecture, the pupil is required to make a scale drawing of a simple column or entablature of one of the Five Orders. In Modeling, one is expected to copy some bas-relief or simple cast from the antique.

The examinations occupy nearly a month. Those who pass successfully have the privilege of study in one of the ateliers and attending lectures for two years without expense. A small fee is demanded, however, on entering the school, for the use of the materials.

The professors visit their respective studios at the school twice each week. The school hours are from 8 to 12.30 A.M. in the winter, and from 7 to 11 A.M. in the summer. Each student is criticised separately. The lectures in Anatomy by Professor Duval may be attended by students outside the school.

Most students work in a private atelier in the afternoon or evening. One of the most frequented schools for drawing is the Académie Colarossi, where men and women study together. M. Colarossi has two schools, one at No. 8 Rue de la Grande Chaumière; also No. 39 Avenue d'Eylau or Victor Hugo. He has an able corps of professors.

The galleries of the national museums are open every day except Monday. One may obtain a card on application which will admit

him to any museum and allow him to work there. Temporary permissions are accorded by the Director; he may be seen on every Tuesday and Thursday from 10 to 2 o'clock. A student should learn the laws and restrictions of these museums.

Not much good art is seen in the shop windows of Paris, and the student must depend largely on the galleries of the Louvre, the Luxembourg, and occasional exhibitions, and the yearly Salons. Every student should visit the churches of Paris, which contain many fine works of art.

The American Art Association at 131 Boulevard Montparnasse furnishes all information regarding boarding-houses, hotels, physicians, the diplomatic service, and art and color merchants. The candidate should present himself at the Association on his arrival in Paris, for by so doing he will save time and money. On the production of credentials he will be given a card of admission to the Association gratis for one month. If considered suitable for membership, he may be admitted by the payment of $2.00 initiation fee and annual dues of $5.00. Information there will be given regarding the curriculum of the "Julien" school, as well as others we have mentioned. Applications for admission should be made to the Secretary.

Living abroad is not as cheap as it is reported in America. Every detail of the expense may be readily learned by application at the American Art Association, and more space need not be devoted to this subject.

Art Study at Home.—The author of this work is satisfied from his own experience and from careful observation and investigation, that art may be studied as successfully in America as abroad, be it in Munich, Paris, or Rome. There is not time to discuss this subject at any length; but the author advises any one, who is about to pursue

the serious study of art, to visit the art schools of this country before incurring the expense of a trip to Europe, and the dangers of studying art in a foreign country.

Art for America must be developed upon American soil; and where a man of strong individuality and character may safely pursue art study abroad, a dozen will sink into servile imitation of foreign masters. There is not the excuse now which was formerly urged for foreign study; we have at this time well furnished museums, and thoroughly equipped schools of art.

Greece did not become great in the fine arts by sending her young men to study in Egypt or the Orient. Until the last few years, one may say until the World's Fair, art study was pursued with difficulty in this country; but now the Art Students' League in New York, the Pratt Institute in Brooklyn, the art schools at Chicago and Boston, or the leagues in Washington, St. Louis, and other cities, afford all necessary advantages. The facilities offered are in most cases better than those to be found in Paris or elsewhere on the continent. The rooms are better ventilated, the surroundings healthier, to say nothing of the purer moral atmosphere, and the life and environment much more conducive to an enduring national art.

The author has developed this subject at some length in his book "Art for America," by Roberts Brothers, but has felt it necessary to insert in a later work this earnest plea for American art, and the men who are giving their lives to make it sincere, noble, and lasting.

APPENDIX.

APPENDIX.

LIST OF SCULPTORS AND THEIR PRINCIPAL WORKS.

AGASIAS (Greek), *b.* 400 B.C. Fighting Gladiator. *Louvre, Paris.*

AGELADAS (Greek), *b.* 500 B.C. No work extant.

AGESANDER (Greek), unknown. One of the three sculptors of Laocoön. *Vatican, Rome.*

AGNOLO DI BACCIO (Italian), *b.* 1460, *d.* 1543. *Palazzo Bartolini, Florence.*

AGNOLIO (Italian), *b.* about 1260.

AGOSTINO (Italian), *b.* about 1265, *d.* about 1350. *Church San Francesco, Siena.*

AGRATE, MARCO FARRERIO (Italian), *b.* about 1500. The four elements.

ALBANO, FRANCESCO (Italian). San Bartholomeo, so called.

ALCHIMEDES (Greek), *b.* 500 B.C. Venus of the gardens.

ALGARDI, ALESSANDRO (Italian), *b.* 1600, *d.* 1654. St. Leo forbidding Attala to enter Rome. *St. Peter's, Rome.*

ALLEGRAIN, CHRISTOPHER GABRIEL (French), *b.* 1710, *d.* 1795. Nude figures.

AMMANATO, BARTHOLOMEO (Italian), *b.* 1511, *d.* 1590. *Ponte Della Trinità, Florence.*

ANDREA PISANO (Italian), *b.* 1270, *d.* 1345. Bronze relief gates at *San Giovanni, Florence.*

ANGUIER, FRANÇOIS (French), *b.* 1604, *d.* 1669. Tomb of Cardinal de Berrulle at *Moulins.*

ANGUIER, MICHEL (French), *b.* 1612, *d.* 1686. Group of the nativity in the church of Valle de Grasse.

APOLLODORUS (Greek), *b.* 350 B.C.

APOLLONIUS (Greek), *b.* 200 B. C. Toro Farnese. *Naples.*

APOLLONIUS (Greek). Torso Belvedere. *Vatican, Rome.*

ARISTIDES (Greek), *b.* 490 B.C.

ARISTOCLES (Greek), *b.* 600 B.C. Of Cydonia.

ARISTOCLES (Greek), *b.* 400 B.C. Of Sicyon.

ARISTOMEDES (Greek), *b.* about 550 B.C. Cybele.

ATHENADORUS (Greek), *b.* about 350 B.C. Portraits busts of women.

ATHENADORUS (Greek). One of the three sculptors of Laocoön. *Vatican, Rome.*

BARTOLINI, LORENZO (Italian), *b.* about 1777, *d.* 1850 A.D. Colossal bust of Napoleon I.

BARTOLOMMEO, MAESTRO (Italian), *b.* about 1390. Porta della Carta, chief entrance to the *Doge's Palace, Venice.*

BARYE, ANTOINE LOUIS (French), *b.* 1795, *d.* 1875. Lion strangling a boa. *Paris.*

BECERRA, GASPERO (Spanish), *b.* 1520, *d.* 1570. Statue of the Virgin. *Madrid.*

BEGARELLI (Italian), *b.* 1498, *d.* 1565. Celebrated modeler in stucco. Intimate of Correggio.

BERNINI, GIOVANNI LORENZO (Italian), *b.* 1598, *d.* 1680. Colonnade at entrance, *St. Peter's, Rome.*

BERRUGUETE, ALONZO (Spanish), *b.* ——, *d.* 1561. Restored the Alhambra. *Spain.*

BOSIO, FRANÇOIS JOSEF (Italian), *b.* 1769, *d.* 1845. Cupid darting arrows.

BOUCHARDON (French), *b.* 1698, *d.* 1762. Fountain of Grenelle, *Paris.*

BRUNELLESCHI, FILIPPO (Italian), *b.* 1377, *d.* 1444. Dome of the Cathedral, *Florence.*

BUONAROTTI, MICHAEL ANGELO (Italian), *b.* 1474, *d.* 1563. Moses. *St. Peter's, Rome.*

BUPALUS (Greek), *b.* 550 B.C.

CAFFIERI, JEAN JACQUES (French), *b.* 1723, *d.* 1792. Statue of Molière.

CAIN, AUGUSTE, *b.* 1822, *d.* 1894. The Eagle defending his prey.

CALAMUS (Greek), *b.* about 450 A.D. Colossal bronze statue of Apollo.

CALICLES (Greek), *b.* about 430 B.C.

CANACHUS (Greek), *b.* about 400 B.C.

CANO, ALONZO (Spanish), *b.* 1600, *d.* 1667. The high altar of the church of Lebrija with statue of Virgin and child at *Grenada.*

CANOVA, ANTONIO (Italian), *b.* 1757, *d.* 1822. Theseus vanquishing the Minotaur. *Vienna.*

CARPEAUX, JEAN BAPTISTE (French), *b.* 1827, *d.* 1875. Group of dancing girls in front of Opera House, *Paris.*

CAVELIER, PIERRE JULES (French), *b.* 1814. Statue of Truth. *Luxembourg, Paris.*

CELLINI, BENVENUTO (Italian), *b.* 1500, *d.* 1570. Perseus and Medusa. *Florence.*

CEPHISODOTUS (Greek), flourished about 17 B.C. The Nine Muses.

CEPHISODOTUS, the younger, lived about 300 B.C. Probably the author of the two youths wrestling in *Tribune, Florence.*

CHANTRY, SIR FRANCIS (English), *b.* 1782, *d.* 1841. Bronze statue of William Pitt. *London.*

CHARES (Greek), *b.* about 300 B.C. The Colossus at *Rhodes.*

CHAUDET, ANTOINE DENIS (French), *b.* 1763, *d.* 1810. Oedipus.

CLEOMENES (Greek), *b.* 300 B.C. Probably author of the Venus de Medici, *Florence.*

CLEVES, CORNEILLE VAN, *b.* 1645, *d.* 1738.

COLOMB, MICHEL (French), *b.* 1431, *d.* 1514. Tomb of François II., Duke of Bretagne.

CORTOT, JEAN PIERRE (French), *b.* 1787, *d.* 1843. The Soldier of Marathon

COUSIN, JEAN (French), *b.* 1500, *d.* 1590. Painting of the Last Judgment.

COUSTOU, GUILLAUME (French), *b.* 1678, *d.* 1746. Two groups, each of which is composed of a horse prancing, and a groom, at entrance Champs-Élysées, *Paris.*

COUSTOU, NICHOLAS (brother of Guillaume), *b.* 1658, *d.* 1733. Group representing the junction of the Seine and Marne. *Paris.*

COYSEVOX, ANTOINE (French), *b.* 1640, *d.* 1720. Two bronzed horses at the *Tuileries, Paris.*

DAMEAS (Greek), *b.* 1400 B.C. Statue of the athlete Milo in the Temple of Olympia.

DANNECKER, JOHANN HEINRICH VON (German), *b.* 1758, *d.* 1841. Ariadne on the panther.

DANTAN, ANTOINE LAURE (French), *b.* 1798, *d.* 1878. Bas-relief of Silène.

DANTAN, JEAN PIERRE (brother of Antoine), *b.* 1800, *d.* 1869. Bust of Cherubini.

DAVID, PIERRE JEAN (French), *b.* 1789, *d.* 1856. Pediment of the Pantheon. *Paris.*

DESBŒUFS, ANTOINE (French), *b.* 1493, *d.* 1562.

DESJARDINS, MARTIN-BOGAERT (Dutch), *b.* 1640, *d.* 1694. Masterpiece. Colossal group, Louis XIV. Destroyed in the Revolution.

DONATELLO, DONATO, DE BELTO DI BARDO (Italian), *b.* 1383, *d.* 1466. St. George, façade of *San Michel, Florence.*

DRAKE, FRIEDRICH (German), *b.* 1805, *d.* 1882. Allegorical group of the eight provinces of Prussia.

DUBOIS, PAUL (French), *b.* 1829.

DUMONT, FRANÇOIS (French), *b.* 1688, *d.* 1726. Statue of thunder-struck Titan.

DUMONT, JACQUES EDME (French), *b.* 1761, *d.* 1844. Grandson of François Dumont.

DUPATY, CHARLES MERCIER (French), *b.* 1771, *d.* 1825. Ajax pursued by Neptune.

DUPRÉ, JEAN or GIOVANNI (Italian), *b.* 1817, *d.* 1882. Pieta, *Siena.*

DÜRER, ALBERT (German), *b.* 1471, *d.* 1528. The Three Graces *Carlsruhe.*

DURET, FRANCISQUE (French), *b.* 1805, *d.* 1866. Statue of Molière, *Hall of Institute, Paris.*

FALCONNET, ÉTIENNE MAURICE (French), *b.* 1716, *d.* 1791. Colossal statue in bronze of Peter the Great, *St. Petersburg.*

FALGUIERE (French), *b.* ——, *d.* ——. Young martyr. *Luxembourg, Paris.*

FLAXMAN, JOHN (English), *b.* 1755, *d* 1826. Shield of Achilles. Group of the archangel Michael and Satan

FRANCHEVILLE, PIERRE (French), *b.* 1548, *d.* 1620. Group, Time bearing away Truth.

FRÉMIET, EMMANUEL (French), *b.* 1824. Joan of Arc. *Paris.*

GEEFS, GUILLAUME (Belgian), *b.* 1806, *d.* 1860. Statues of Rubens and Malebran.

GEEFS, JAN JOSEPH (Belgian), *b.* 1811, *d.* 1885. Adonis departing to the chase.

GHIBERTI, LORENZO (Italian), *b.* 1378, *d.* 1455. Bronze gates of the Baptistry, *Florence.*

GIOVANNI, PISANO, son of Nicola (Italian), *b.* ——, *d.* 1320.

GIRARDON, FRANÇOIS (French), *b.* 1630, *d.* 1715. Sculptures of the "Fountain of the Pyramids."

GLAUCIAS (Greek), *b.* 480 B.C.

GLAUCUS (Greek), *b.* at Chios, 6th century B.C.

GLYCON (Greek). Farnese Hercules.

GOUJON, JEAN (French), *b.* 1530, *d.* 1572. Bas-reliefs of Naiads for the "Fountain of the Innocents," *Paris.*

GUILLAIN, SIMON (French), *b.* 1581, *d.* 1658. The statues in the church of the Sarbonne, *Paris.*

GUILLAUME, JEAN BAPTISTE CLAUDE, *b.* 1582, *d.* 16—. The tomb of the Gracchi.

HEGIAS (Greek), *b.* 450 B.C. Statue of Minerva.

HOUDON, JEAN ANTOINE (French), *b.* 1741, *d.* 1828. Statue of Voltaire. *Theatre Français, Paris.*

HUSSON, JEAN HONORE ARISTIDE (French), *b.* 1803, *d.* 1864. Bas-relief of Dante and Virgil.

JOHN OF BOLOGNA (Flemish), *b.* 1524, *d.* 1608. The Flying Mercury. *Bargello, Florence.*

KAESCHMANN, JOSEPH (German). Jason carrying away the golden fleece.
KISS, AUGUSTUS (German), *b.* 1802. *d.* 1865. Amazon attacked by a tiger *Berlin.*
KRAFFT, ADAM (German), *b.* 1429, *d.* 1507. A tabernacle in the church of *St. Lawrence, Nuremberg.*

LAMAIRE, PHILIPPE HENRI (French), *b.* 1798, *d.* 1880. Pediment for *Madeleine, Paris.*
LYSIPPUS (Greek), *b.* about 330 B.C. Apoxyomenus. *Vatican, Rome.*

MILLET, AIMÉ (French), *b.* 1819, *d.* 1891. Ariadne.
MOITTE, JEAN (French), *b.* 1746, *d.* 1810. A bas-relief of France.
MONTELUPO DA BACCIO (Italian), *b.* 1445, *d.* 1533.
MONTORSOLI, FRA GIOVANNI ANGELO (Italian), *b.* 1500, *d.* 1563. Fountain in front of *Cathedral, Messina.*
MYRON (Greek), lived 480 B.C. The Discobolus. *Vatican, Rome.*

NAUCIDES (Greek). Mercury.

ONATAS (Greek), lived about 460 B.C. Statue of Apollo.
ORCAGNA, ANDREA DI CIONE (Italian), *b.* about 1308, *d.* about 1368. The Loggia di Lanzi. *Florence.*

PAGOU (French), *b.* 1730, *d.* 1809. Statue of Pascal.
PERRAUD (French), *b.* 1821, *d.* 1876.
PHIDIAS (Greek), *b.* about 485 B.C. Sculptures of the Parthenon.
PHITEUS (Greek), *b.* about 353 B.C. Tomb of Mausolus, king of Caria.
PIGALLE, JEAN BAPTISTE (French), *b.* 1714, *d.* 1785. Monumental group at Strasburg, in honor of Marshall Saxe.
PILON, GERMAIN (French), *b.* 1515, *d.* about 1590. A marble group of Three Graces. *Louvre, Paris.*
PISANO, GIOVANNI, son of Niccolò (Italian), *b.* 1238, *d.* 1320. High altar in Cathedral of *Arezzo.*
PISANO, NICCOLÒ (Italian), *b.* 1226, *d.* 1273.
POLYCLES (Greek), *b.* about 370 B.C. Hermaphrodite.
POLYCLETUS (Greek), *b.* about 450 B.C. Doryphorus the Spear-bearer.
POLYDORUS (Greek). One of the sculptors of the Laocoön.
PORTA, DELLA, GIACOMO (Italian), *b.* 1525, *d.* 1605. Portal of St. John. *Lateran, Rome.*

PRADIER, JACQUES (French), *b.* 1792, *d.* 1852. Psyche ; Atlanta and Niobe group *Louvre.*

PRAXITELES (Greek), *b.* about 360 B.C. Hermes, at Olympia.

PUGET, PIERRE (French), *b.* 1622, *d.* 1694. Milo of Crotona.

RAUCH, CHRISTIAN (German), *b.* 1777, *d.* 1857. Statue of Frederick the Great. *Berlin.*

ROBBIA, ANDREA DELLA (Italian), *b.* 1444, *d.* 1527. Works in enameled terra-cotta.

ROBBIA, GIOVANNI DELLA (Italian), *b.* 1470.

ROBBIA, GIROLAMO DELLA (Italian). Statue of Catherine di Medicis.

ROBBIA, LUCA DELLA (Italian), *b.* about 1388, *d.* 1463. Reliefs on the Campanile and Choir of the *Cathedral*, *Florence.*

ROLLAND, PHILIPPE LAURENT (French), *b.* 1746, *d.* 1816. Statues of Homer and Solon.

ROMAN, JEAN BAPTISTE LOUIS (French), *b.* 1792, *d.* 1835.

ROUBILIAC, LOUIS FRANÇOIS (French), *b.* 1695, *d.* 1762. Statue of Shakespeare.

RUDE, FRANÇOIS (French), *b.* 1784, *d.* 1855. Relief on Arc of Triumph, *Paris.*

SANSOVINO, JACOPPO TATTI (Italian), *b.* 1479, *d.* 1570 Statues of Mars and Neptune. *Doge's Palace*, *Venice.*

SCHADOW, JOHANN GOTTFRIED (German), *b.* 1764, *d.* 1850. Statue of Frederick the Great.

SCHWANTHALER, LUDWIG MICHAEL (German), *b.* 1802, *d.* 1848. Statue of Bavaria. *Munich.*

SCOPAS (Greek), *b.* 400 B.C. Statues of Venus, Vesta and Apollo.

SIMART, PIERRE CHARLES (French), *b.* 1806, *d.* 1857. Statues and reliefs for the *Louvre.*

SOLA, ANTONIO (Spanish), *b.* 1790. Group of Daoiz and Velarde.

STEINBACH, ERWIN VON (German), *b.* ——, *d.* 1318. Worked upon his own design for the door of the tower of the *Strasburg Cathedral.*

THEODORUS (Greek), 600 B.C. An early sculptor in bronze.

THIERRY, JEAN (French), *b.* 1669, *d.* 1739. Worked in Spain for Philip V.

THOMAS, JOHN (English), *b.* 1813, *d.* 1862. Statues in the Houses of Parliament

THORNYCROFT, HAMO, *b.* March 9, 1850.

THORWALDSEN, ALBERT BERTEL (Danish), *b.* 1770, *d.* 1844. Lion of Lucerne.

TIMOTHEUS (Greek), *b.* about 350 B.C. Statue of Diana.

VERROCCHIO, ANDREA (Italian), *b.* 1432, *d.* 1488. Equestrian statue of Colleoni. *Venice.*

VISCHER, PETER (German), *b.* 1460, *d.* 1540. Tomb of St. Sebald. *Nuremberg.*

WESTMACOTT, SIR RICHARD (English), *b.* 1775, *d.* 1856. Statue of George III. *Windsor.*

WESTMACOTT, RICHARD (English), *b.* 1799, *d.* 1872. David the slayer of Goliath.

CERTAIN VALUABLE BOOKS ON SCULPTURE.

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"The Museum of Fine Arts, Boston — Catalogue of Casts." *Edward Robinson.* Boston: Houghton, Mifflin & Co.

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"Anatomy for Artists." *John Marshall;* with plates by John S. Cuthbert. Cincinnati: Robert Clark & Co.

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Crowe's "Hand-book of German, Flemish and Dutch Art."

Lubke's "History of Art"

Mrs. Clement's "Painters, Sculptors, Architects, Engravers and their Works."

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Charles Waldstein's "Phidian Essays."

Davidson's "Parthenon Frieze" and "Essays."

Goodyear's "Evolution of Ornament" and other works.

Lucy Mitchell's "History of Sculpture."

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Johnson, E. W., "The Studio Arts."

"Pharaohs, Fellahs and Explorers." *Amelia B. Edwards.* New York: Harper & Bros.

Maspero's "Egypt and Assyria."

Hoppin's "Early Renaissance."

"Two French Sculptors." *W. C. Brownell.* In Century Magazine for Nov., 1890.

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Figaro Salon. New York: Boussod, Valadon & Co.

The Portfolio. London: Seeley & Co.

L'Art. Paris.

ART PUBLICATIONS.

Foremost among the art publications of America one should mention the *Art Interchange*. This monthly compares favorably with the English *Art Journal*, and is better suited to our needs. Its information is varied, but not too much so for a nation where every branch of art is being earnestly studied. The author advises all art students to read the *Interchange*, and so keep pace with contemporaneous art movements. Its editorial page is not the slave of its advertising sheet, as is too often the case with other art publications and reviews.

The art publications of George Barrie & Co. of Philadelphia are worthy of kindest notice. Mr. Barrie has published many expensive books at a financial loss, because of his love for true art. His publications compare favorably with any in the world.

AMERICAN BRONZE FOUNDERS AND FOUNDRIES.

It would seem fitting that the industry of bronze founding should have some mention in this book, and while there are at the present time numerous successful foundries in America, I shall make mention only of those of which I have some personal knowledge.

M. H. Mosman, of Chicopee, Mass., is a founder of bronze who brings to his work not only the fine qualities of an artist, but a remarkable and noteworthy devotion. It was at the Chicopee Foundry that the equestrian statue of Washington, by Thomas Ball, was cast. This work has stood the test of time and weather. Mr. Mosman has discovered a happy secret for fusing bronze. The author recommends this foundry and the sincere man who stands at its head.

The Gorham Manufacturing Company of New York has established a successful foundry at Providence, R. I. This department is in the hands of Mr. J. H. Buck and his son, A. A. Buck, who bring intelligence and courtesy to their work. Their terms are moderate, and the work conscientiously executed. They have shown remarkable success in the casting of small pieces, animals, statuettes, etc. The author believes this company, and the gentlemen in charge of this department, to be in every way trustworthy.

The Henry Bonnard Bronze Company has had for some years a successful foundry in New York City. This company refers with pride to a number of large works executed at its foundry, which have given satisfaction to American sculptors.

There is another foundry in New York City which has been conducted for many years by Mr. P. E. Guerin at 21 and 23 Jane St. Here excellent small work has been done. John Rogers has had the originals of his groups cast there, and he speaks highly of the integrity of this house.

The author is satisfied that bronze casting can now be done in this country as successfully as abroad; that is, the casting in sand moulds The new process of casting in wax moulds, or the revival of old processes, is conducted with more safety in Rome, Paris, and England; but he believes that in the near future casting by the "lost wax" method will become popular here, and be accomplished as successfully as the casting by sand moulds. It is only right that American sculptors should encourage, as far as they are able, the American founders; for it has taken courage and endurance to open and sustain a bronze foundry in this country where art is still in its beginnings.

THE PANTOGRAPH PRINCIPLE.

The following description of a new machine involving the pantograph principle may prove helpful and interesting. At one end of a horizontal bench is a universal joint to which is attached a rod or arm. This arm supports two tool carriages, and has a longitudinal groove for convenience in adjusting and keeping the carriages in their proper position. One of these carriages supports a stump or runner, and the other a graving point. The carriages are also connected by a rod in such a manner that in conjunction with the arm supporting them perfect freedom of motion in every direction is attained with the stump, which is, of course, exactly duplicated by the graving tool. On the bench are two turn-tables so adjusted that their position can be varied at will and revolved without changing their relative positions. The tables are fixed opposite the carriages, and one receives the model and the other the block of plaster or other material which is to be transformed into a reproduction of the model on a reduced or enlarged

scale. The operator holds the stump lightly, and makes it pass over the entire surface of the model, while at the same time the sharp steel graver cuts into the plaster block, and reproduces mathematically the model, inasmuch as both tools work from the same centre. The proportions of the reproduction are fixed by the mathematical adjustment of the turn-tables and carriages above mentioned. As all the parts slide on their supports, the enlargement or reduction is not in the least arbitrarily fixed, but can be changed as much or as little from any given size within the limits of the machine as the operator may wish. It is obvious that in a complete revolution of the tables, an infinity of points on the model may be touched by the stump, and exactly duplicated by the graver on the reproduction; consequently it is possible to obtain a reproduction of the entire surface of the model. By the variety of tools which may be used, the large planes as well as the finer surfaces of the model are quickly reproduced, making it possible to complete a complicated piece, not only with absolute accuracy, but also with great rapidity.

MR. IRA G. FRENCH has invented a modeling machine embodying the pantograph principle, which the author has at present in his studio, and which, from practical test, he has found to be an entire success. It may be moved easily from one part of the studio to another, which is a great convenience. The author has used other machines, and finds this the only moulding machine in which there is no lost motion or distortion. It will enlarge or reduce work with the same fidelity.

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SUMNER LINE, CONDENSED FORM. STAR

Watch time:	16^h	29^m	48^s			
C. – W.:	– 1	23	50			
Chr. time:	15	5	58			
Chr. corr'n:		– 2	28		Obs'd alt.:	40° 3′
G. M. T.:	15	3	30		Index:	+ 5
R. A. mean sun:	17	42	10		Table 6:	– 1
Corr'n, past noon:		2	28		Table 7:	– 5
Greenw'h sid. time:	8	48	8		Corr'd alt.:	40 2
R. A. of Sirius:	6	41	34			
Greenw'h hour-angle:	2	6	34			
D. R. long.:	1	22	44 E.	(2)		
T:	3	29	18	(3)		

T or $(24^h - T)$[1]:	3^h 29^m 18^s	(3) hav.:	9.28872	(6)
Dec.:	– 16° 36′	cos:	9.98151	(5)
D. R. lat.:	– 35 20	cos:	9.91158	(4)
Sum of 3 = hav. X:			9.18181	(7)
No. hav. X:			0.15194	(10)
Lat. – Dec.:	18° 44′	(8); No. hav.:	0.02649	(9)
Sum of 2 = No. hav. Z:			0.17843	(11)
Z:			49° 59′	(12)
Computed alt. = 90° – Z:			40 1	(13)
Obs'd alt., corr'd:			40 2	(14)
Diff.:			1	(15)

Index No.: 7550
Azimuth: 280°
Lat. diff.: 0′.2 Dep.: 1.0 Long. diff.: 1′.2
Sumner pt. lat.: – 35° 20′ (16); long.: 20° 40′ E. (17)
Bearing of Sumner line: 10° (18)

We have now, in the foregoing examples, illustrated the manner of determining a Sumner line completely by ascertaining the latitude and longitude of one point on the line (the Sumner point), and the bearing of the line itself at that point. It may be desired to draw the line on the chart, which will always interest the navigator if he is near the coast and has a large-scale chart. To draw it, we merely locate the Sumner point on the chart by its latitude and longi-

[1] See footnote, p. 116.

tude, and then draw the line through the point so that it will make with the meridian an angle equal to the bearing which has been computed for the line. The Sumner line should be extended in *both* directions from the Sumner point, for any convenient distance, in such a way that the point will be near the middle of the line.

We can now gain a better understanding as to Sumner navigation by comparing the results obtained in one of the foregoing examples with the corresponding calculation of the same example as a time-sight. Thus from the same observation (pp. 104, 119)

As a Time-Sight	As a Sumner Observation
From D. R. latitude 42° 20′ N.; D. R. longitude 35° 16′ W., we found the ship's longitude to be 35° 24′ W.	From D. R. latitude 42° 20′ N.; D. R. longitude 35° 16′ W., we found the Sumner point to be in latitude 42° 17′; longitude 35° 19′ W.; and azimuth of Sumner line, 307°.

Starting with the same observed altitude, and the same D. R. position of the ship, we get quite different results by the two methods of calculation. The time-sight gives us nothing but a longitude; and it will be the correct ship's longitude only if the D. R. latitude was also correct (p. 101). Therefore the time-sight calculation leaves us with *both* latitude and longitude still affected by possible errors in the D. R. latitude.

On the other hand, the Sumner calculation gives us both a latitude and a longitude, but neither belongs to the ship's position. They both belong to the position of the Sumner point, but they are free from the effects of any D. R. errors. They fix the Sumner point only, but they fix it *correctly*. Furthermore, our knowledge that the ship is somewhere on the Sumner line is also a fact, free from error. So what we learn from the Sumner method is sure; what we get by the older methods is all really D. R. information in some

degree. The Sumner method is independent of D. R., an advantage of which the value cannot be estimated too highly.

Furthermore, it can be shown mathematically (cf. p. 111) that a single observation can never really do more than determine a line on which the ship must be. Even a noon-sight does no more than this; for in determining the ship's latitude, it really only makes known a horizontal line (the ship's latitude parallel) on the chart. In other words, for a noon-sight the Sumner line is horizontal, or has a bearing of 90°. And it will always come out 90°, if a noon-sight is worked as a Sumner observation.

But the principal purpose of our present comparison of the two methods of calculation is to warn the navigator against falling into the error of imagining the ship to be at the Sumner point. The observation does no more than tell us where the Sumner point is, and that the ship is somewhere on the line; so far as the observation is concerned, all points on the line are equally likely to be the ship's true position. Therefore it is misleading to call the Sumner point the ship's "most probable position." Were it so, a second observation, made later in the day, would give another "most probable position" of the ship. We should then be naturally led to take as the ship's final location a point midway between the two "most probables," ascribing their divergence to possible errors of observation. But the ship's real position we already know (p. 111) to be at the *intersection* of the two Sumner lines resulting from the two observations. And this intersecting point may be many miles from both "most probables," and from the above-mentioned midpoint between them.

Less than two observations cannot fix the ship's position completely; when two have been made, a correct application of the Sumner method requires that the intersection point of two Sumner lines be determined by calculation. But before explaining the method of doing this, we must describe an excellent alternative way of making Sumner

calculations such as we have given in the above examples. The results are the same results as before, but they are obtained with less work, and quite without logarithms, by means of special tables such as our Table 13 (p. 292),[1] which we shall call Kelvin's Sumner Line Table.

This table has a pair of arguments (p. 11), a and b, a appearing at the heads of the tabular columns, and b in the left-hand column of each page. Corresponding to these two arguments, the table gives two angles, K and Q; so that whenever a and b are given we can find the corresponding K and Q; or, if a and K should be given, we can find the corresponding b and Q.

In the Sumner problem we obtain, by preparatory calculation (cf. pp. 119, 123), the following data:

Declination of sun (or star); D. R. latitude; D. R. longitude; T, the ship's apparent time of the observation for the sun, or the hour-angle for a star;

and we wish to get the computed altitude and the azimuth.

The principle on which Table 13 depends is that the D. R. latitude and longitude being always somewhat uncertain, we can, if we choose, change them by reasonable amounts before beginning our calculations. The Sumner point will then be determined by its distance and bearing from the *changed* D. R. point, instead of the original D. R. point. By this device the tabular calculation is much facilitated. The use of the table is easy after a little practice, the work being divided into a series of separate operations. In describing these operations we have used small subscript numbers, to distinguish the several arguments, etc.; as, for instance, in Operation 1 we use a_1, b_1, K_1.

[1] These tables were first published by Lord Kelvin in 1876. More extended ones were recently issued by Lieutenant de Aquino, of the Brazilian Navy; and these were reprinted by the Hydrographic Office, United States Navy, in 1917. Aquino also improved Kelvin's method of using his table.

OPERATION 1, requiring no interpolation. Enter Table 13 with:

Arg. $a_1 =$ declination, taken without regard to + or − sign, and correct to the nearest whole degree only;
Arg. $b_1 = T$, if T is between 0^h and 6^h;
$= 12^h - T$, if T is between 6^h and 12^h;
$= T - 12^h$, if T is between 12^h and 18^h;
$= 24^h - T$, if T is between 18^h and 24^h;
and before use b_1 must be turned into degrees with Table 9 (p. 249). It need be correct to the nearest degree only. This proceeding will make b_1 always less than 90°.

Then take from the table the tabular angle K_1, also correct to the nearest degree only.

OPERATION 2, requiring simple interpolation. Enter the table a second time with:

Arg. $a_2 =$ the K_1, obtained in Operation 1.

Then, under this a_2, run down the K-column until you find the declination (taken without regard to + or − sign); so that, in other words, $K_2 =$ declination.

Take from the table the angle Q_2, which stands next to the declination K_2, and also the b_2, which is in the left-hand argument column, in the same horizontal line with the declination K_2 in the K-column. It will rarely be possible to find the declination (which must this time be exact to the nearest minute) in the K-column; so that a simple interpolation will be necessary in getting Q_2 and b_2. An example of this interpolation will be found on page 129; and, as we shall see, it is practically the only numerical calculation required in the whole problem. The Kelvin method is very much shorter than it looks.

The angle Q_2 is used in choosing the longitude of the "changed D. R. point"; the latitude of that point will be found in Operation 3. To utilize Q_2 for a sun observation, calculate the Greenwich apparent time (G. A. T.) of the

observation, as on page 102, line (8), and turn it into degrees with Table 9 (page 249). Then:

(1) W. long. of changed D. R. point = G. A. T. $- Q_2$, if, in Operation 1, T was less than 6^h;
(2) W. long. of changed D. R. point = G. A. T. $- (180° - Q_2)$ if, in Operation 1, T was between 6^h and 12^h;
(3) W. long. of changed D. R. point = G. A. T. $- (180° + Q_2)$ if, in Operation 1, T was between 12^h and 18^h;
(4) W. long. of changed D. R. point = G. A. T. $- (360° - Q_2)$ if, in Operation 1, T was between 18^h and 24^h.

When the subtractions in these formulas cannot be made, the G. A. T. may be increased by 360°; and when the west longitude comes out greater than 180°, subtract it from 360°, and call it east longitude.

In the case of a star, we must use, in the above formulas, the Greenwich hour-angle, instead of the G. A. T. See page 105, line (11), for the method of obtaining it.

OPERATION 3, requiring no interpolation. Enter the table a third time with:

Arg. $a_3 = K_1$, again as obtained in Operation 1.
(5) Arg. $b_3 = 90° - (b_2 +$ changed D. R. lat.), if latitude and declination are of opposite signs, one + and one −;
(6) Arg. $b_3 = (b_2 +$ changed D. R. lat.) $- 90°$, if T was between 90° and 270°;
(7) Arg. $b_3 = 90° - (b_2 -$ changed D. R. lat.), if latitude is less than b_2;
(8) Arg. $b_3 = 90° + (b_2 -$ changed D. R. lat.), if latitude is greater than b_2.

In choosing among formulas (5) to (8), give them precedence in order; do not use (7) or (8) if the conditions stated for (5) or (6) are satisfied. And at this point, use your privilege of choosing any reasonable changed D. R. latitude for the ship; and choose one that differs as little as possible from the original D. R. latitude, and that yet makes b_3 a whole number of degrees. In this way, all further

interpolation is avoided. Having once chosen among the formulas, the latitude is used without regard to + or − signs.

To complete Operation 3, having entered the table with the pair of arguments a_3 and b_3, take out the tabular K_3 and Q_3.

K_3 is now the computed altitude, to be used (p. 113) in locating the Sumner point from the changed D. R. point; and Q_3 is the sun's true azimuth, which will always come from the table less than 90°. If the ship is in the northern hemisphere, this azimuth must be counted from the north point of the horizon if, in Operation 3, we used formulas (6) or (7); or from the south point of the horizon, if we used formulas (5) or (8). With the ship in the southern hemisphere, interchange the north and south points of the horizon in these directions. And in both hemispheres, the azimuth will of course be counted toward the east or west, according as the observation was a "forenoon" or "afternoon" one (cf. p. 120).

We shall now use Table 13 for the example given on page 119 in condensed form. We have (p. 127):

Operation 1.

a_1 = dec. = 23°, p. 119, line (1), to the nearest degree;

$b_1 = T = 2^h\ 41^m\ 31^s$, p. 119, line (4) = 40°, to the nearest degree; and, with a_1 and b_1 as arguments, Table 13 gives (p. 298): K_1 = 36°, to the nearest degree.

Operation 2.

$$a_2 = K_1 = 36°.$$
$$K_2 = 23°\ 24', \text{ p. 119, line (1)}$$

and, with a_2 and K_2, we must find Q_2 and b_2. Running down the column headed a = 36° (p. 302), we find:

When $K_2 = 23°\ 5'$, $Q_2 = 39°\ 43'$, $b_2 = 29°$,
When $K_2 = 23°\ 51'$, $Q_2 = 40°\ 0'$, $b_2 = 30°$.

We wish to interpolate for $K_2 = 23°\ 24'$, which is 19′ down from 23° 5′ toward 23° 51′. The whole distance from

$23° 5'$ to $23° 51'$ is $46'$. Therefore we must interpolate down $\frac{19}{46}$ of the whole interval from $Q_2 = 39° 43'$ to $Q_2 = 40° 0'$. The difference between these two Q_2's is $17'$; therefore the final Q_2, belonging to $K_2 = 23° 24'$, is $39° 43' + \frac{19}{46} \times 17' = 39° 43' + 7' = 39° 50'$. Similarly, the difference between the two b_2's being $60'$, the final value of b_2, for $K_2 = 23° 24'$, is $29° + \frac{19}{46} \times 60' = 29° 25'$. These two little interpolations are *practically all the calculation* required in the whole problem.

To find the longitude of the changed D. R. point from the above $Q_2 = 39° 50'$, we take from page 102, line (8),

Greenwich apparent time of observation,	$5^h\ 2^m\ 35^s$
which, by Table 9 (p. 249) is,	$75° 39'$

We now use formula (1), page 128, because T, in Operation 1, was less than 6^h. We get:

W. long. of ch'd D. R. pt. $=$ G. A. T. $- Q_2 = 75° 39' - 39° 50'$
$= 35° 49'$ W.

Operation 3.

$$a_3 = K_1 = 36°.$$

The D. R. latitude is $+ 42° 20'$ (p. **119**, line (9)); and as the declination is $-$, we choose formula (5), page 128. This, *without* changing the D. R. latitude, would give $b_3 = 90° - (b_2 + \text{D. R. lat.}) = 90° - (29° 25' + 42° 20') = 90° - 71° 45'$; but by choosing a *changed* D. R. latitude of $42° 35'$, we shall make b_3 a whole number of degrees. So we have:
$b_3 = 90° - (b_2 + \text{changed D. R. latitude}) = 90° - (29° 25' + 42° 35') = 90° - 72° = 18°$.

Now we enter the table with the arguments $a_3 = 36°$, and $b_3 = 18°$, and obtain, without interpolation (p. 302):

$$K_3 = \text{computed altitude} = 14° 29',$$
$$Q_3 = \text{sun's true azimuth} = 37° 22'.$$

This azimuth must be counted from the south point of the horizon, since we used formula (5) in Operation 3; and

as the observation was an afternoon one, the correct azimuth will be S. 37° 22′ W. (cf. p. 19). Counted in the United States Navy way, from the north toward the east, and so around to 360°, the azimuth will be 217° 22′.

On page 119, we found: Computed altitude, 14° 26′; azimuth, 217°.

This computed altitude differs by 3′ from the value just found by Table 13. The difference is due to our having changed the D. R. point.

From the changed D. R. point, in latitude 42° 35′ N.; longitude 35° 49′ W., we now calculate (see Condensed Form, next page) the position of the Sumner point to be: latitude 42° 34′ N.; longitude 35° 50′ W. The former position, as obtained on page 119, was: latitude 42° 17′ N.; longitude 35° 19′ W.

These two Sumner point positions should lie on the same Sumner line if the method of Table 13 gives correct results; and they will satisfy this test, if the bearing of a line joining them agrees with the azimuth of the Sumner line, which is 217° + 90° = 307°. From the two Sumner point positions we have: latitude difference = 17′; longitude difference = 31′; departure (Table 2, p. 174) = 23.0. The traverse table (p. 164) gives, for latitude 17, departure 23.0, the distance 28, course 307°. The agreement is perfect, and shows that the same Sumner line passes through both points, though they are 28 miles apart. This test also shows that the calculation may indicate *any* point on the Sumner line as *the* Sumner point, f the D. R. position of the ship is uncertain: and so we again call attention to the error of taking the calculated Sumner point as the ship's most probable position (cf. p. 125).

We now, as usual, repeat the above calculation by Table 13, in condensed form, and including the final determination of the position of the Sumner point from the changed D. R. point.

SUMNER LINE BY TABLE 13, CONDENSED FORM. SUN

[The following is taken from page 119.]

Decl., 4^h:	$-23° 23'.7$	Eq. of time:	$+3^m 22^s.3$
H. D.:	0.1	H. D.:	1.2
Decl., $4^h 59^m$:	$-23\ \ 24$	Eq. time:	$+3\ \ 21.1$

Watch time:	2^h	29^m	58^s			Obs'd alt.:	14° 19′
C. − W.:	2	27	8			Index:	+ 4
Chr. time:	4	57	6			Table 6:	+ 12
Chr. corr'n:		+ 2	8			Table 7:	− 5
G. M. T.:	4	59	14			Corr'd alt.:	14 30
Eq. of time:		+ 3	21			D. R. lat.:	42° 20′ N.
G. app. time:	5	2	35			D. R. long.:	35° 16′ W.
D. R. long.:	2	21	4 W.	(3)			
Ship's app. time, T:	2	41	31	(4)			

[The following is calculated with Table 13.]

OPERATION 1

a_1 = dec. = 23°
$b_1 = T$ = $2^h 41^m 31^s$(4)
= 40°
Table 13, K_1 = 36°

OPERATION 2

$a_2 = K_1$ = 36°
K_2 = dec. = 23° 24′
Table 13, Q_2 = 39° 50′
Table 13, b_2 = 29° 25′

Greenwich app. time = $5^h 2^m 35^s$ = 75° 39′
By page 128, form. (1), W. long. of changed D. R. pt. = G. A. T. − Q_2
= 35° 49′ W.
Lat. of changed D. R. pt. = 42° 35′ N.

OPERATION 3

$a_3 = K_1$ = 36°
b_3 = 90° − (b_2 + changed D. R. lat.) = 18°
Table 13, K_3 = comp'd alt. = 14° 29′
Table 13, Q_3 = azimuth of sun = 37° 22′
or, by U. S. Navy = 217° 22′
Azimuth of Sumner line = 217° 22′ + 90°
= 307° 22′

Dist. of Sumner pt. from changed
D. R. pt. = corr'd obs'd alt. − comp'd alt. = 1′ or 1 mile
Bearing of Sumner pt. from changed D. R. pt. = 217°,
since comp'd alt. is less than obs'd alt.
Dist. 1, on course 217°, gives lat. diff., 0′.8; dep., 0.6; long. diff., 0′.8
Lat. of Sumner pt. = lat. of ch'd D. R. pt. − lat. diff. = 42° 34′ N.
Long. of Sumner pt. = long. of ch'd D. R. pt. + long. diff. = 35° 50′ W.

A practised navigator can make the above complete calculation in a few minutes, as there are no logs used; and any one can easily obtain the necessary practice at sea by simply forming the habit of working his sights both as time-sights and as Sumners. To illustrate the subject further, we now give, in condensed form, the Star Example of p. 123, worked by Table 13.

SUMNER LINE BY TABLE 13, CONDENSED FORM. STAR

[The following is taken from page 123.]

Watch time:	16^h	29^m	48^s
C. – W.:	– 1	23	50
Chr. time:	15	5	58
Chr. corr'n:		– 2	28
G. M. T.:	15	3	30
R. A. mean sun:	17	42	10
Corr'n, past noon:		2	28
Greenwich sid. time:	8	48	8
R. A. of Sirius:	6	41	34
Green. hour-angle:	2	6	34
D. R. long.:	1	22	44 E.
T:	3	29	18

Obs'd alt.:	40°	3′
Index:		+ 5
Table 6:		– 1
Table 7:		– 5
Corr'd obs'd alt.:	40	2
Dec. of Sirius:	– 16	36
D. R. lat.:	– 35	20

[The following is calculated with Table 13.]

OPERATION 1

a_1 = dec. = 17°
$b_1 = T$ = 3^h 29^m 18^s
= 52°
Table 13, K_1 = 49°

OPERATION 2

a_2 = K_1 = 49°
K_2 = dec. = 16° 36′
Table 13, Q_2 = 51° 57′
Table 13, b_2 = 25° 49′

By page 128, form. (1),
W. long. of changed D. R. pt. = Green. hour-angle – Q_2[1]
= 339° 41′
= 20° 19′ E.
Lat. of changed D. R. pt. = – 35° 49′

OPERATION 3

a_3 = K_1 = 49°
By form. (8), page 128, b_3 = 90° + (b_2 – changed D. R. lat.) = 80°
Table 13, K_3 = comp'd alt. = 40° 15′
Table 13, Q_3 = az. of Sirius = N. 81° 25′ W.
or, by U. S. Navy = 278° 35′
Az. of Sumner line = 368° 35′, or 8° 35′

Dist. of Sumner pt. from changed
D. R. pt. = corr'd obs'd alt. – comp'd alt. = – 13′ or 13 miles
Bearing of Sumner pt. from changed D. R. pt. = 99°,
since comp'd alt. is greater than obs'd alt.
Dist. 13, on course 99°, gives lat. diff., 2′.0; dep., 12.8; long. diff., 15′.9
Lat. of Sumner pt. = lat. of ch'd D. R. pt. + lat. diff. = – 35° 51′
Long. of Sumner pt. = long. of ch'd D. R. pt. + long. diff. = 20° 35′ E.

To complete this part of our subject, it remains to show how the position of the ship can be found at the intersection of two Sumner lines (pp. 111, 125) resulting from two different observations. Figure 18 explains the nature of the problem; and it is almost exactly the same figure and

[1] Q_2 being larger than the Greenwich hour-angle, the latter was increased by 360°, to make the subtraction possible (p. 128).

problem treated in Chapter V, when we discussed fixing a ship's position by means of "bearings from the bow" (p. 54).

The two Sumner lines in Fig. 18 are SL and $S'L$, passing through the two Sumner points S and S', whose latitudes and longitudes are known by calculation from the observed altitudes. The bearings or azimuths of the two Sumner lines from the north are the two angles NSL and $N'S'L$, which are also known from the previous calculations. It is now required to find the latitude and longitude of the intersection point L, where the ship is situated.

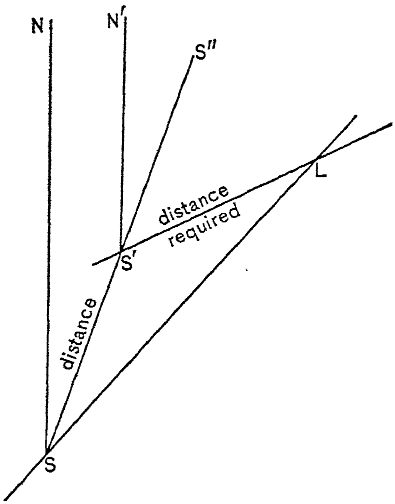

FIG. 18.—Intersection of Sumner Lines.

The similarity of this problem to the former one in Chapter V becomes plain, if we imagine a second ship sailing from one Sumner point to the other, as from S to S', and taking bearings from her bow upon *our* ship, located at L. These bearings will be the two angles $S'SL$ and $S''S'L$. If the second of these angles should happen to be just twice as big as the first, the distance $S'L$ between the two ships at the time of the second bearing would be equal (p. 54) to the distance SS' run by the imagined ship between the two observations.

This would enable us to fix the position of the imagined ship at S', if L were a lighthouse ashore. But if L is our ship, and S' a Sumner point of known position, the same observations of bow bearings would fix the position of our ship at L. Nor is it necessary (or possible) to measure

such imaginary bearings, or read the patent log to get the distance run by an imagined ship.

For the distance and bearing of the second Sumner point from the first can be obtained from their known latitudes and longitudes with the traverse table. Thus the line SS' (marked "distance") and the bearing (or course) angle NSS' become known. Furthermore, the "bow bearing" at S is the angle $S'SL$, and it is equal to the difference $NSL - NSS'$. We have just seen that NSS' is obtained from the traverse table; and NSL is the calculated azimuth of the Sumner line through S. In a similar way we get the other "bow bearing" $S''S'L$. If this were twice the first one, the "required distance" $S'L$ in the figure would be equal to the known distance SS' between the two Sumner points. If not, it can be easily shown mathematically that:

(1) Required distance = known distance $\times$ a factor,
(2) log factor = $\sin S'SL - \sin (S''S'L - S'SL)$.

By these simple formulas the required distance $S'L$ might be found: and as we also know the latitude and longitude of the Sumner point S', and the azimuth or bearing of $S'L$, the traverse table will make known the latitude and longitude of the ship at L. It is to be noted also that as we are at liberty to call either of the Sumner points S', it is desirable to call that one S' which has the larger "bow bearing," so that there will be no difficulty about subtracting $S'SL$ from $S''S'L$.

The factor of formula (2) above can practically always be found in our Table 14, the Sumner Intersection Table, without using logarithms. The pair of arguments of the table are the smaller "bow bearing" and the larger "bow bearing"; the tabular number is the factor of formula (1) above, and will always give the distance of the intersection point from that one of the two Sumner points for which the bow bearing was the larger.

And it should not be forgotten that the Sumner line really

extends equally in both directions (p. 124) from the Sumner point, whereas, in Fig. 18, we have extended it mainly in the direction of the intersection point L. Now the calculated azimuth of any Sumner line may be changed 180° at will, because the bearings of the two ends of the line from the Sumner point differ by 180°, and we may take the bearing of the line to be the bearing of either end from the Sumner point in the middle of the line. Figure 18 shows, however, that for the purpose of the present problem we must choose the bearing of that end of the line which is nearest the point of intersection L; nor does the choice ever offer difficulty, because the known D. R. position of the ship at L, when compared with the known positions of the two Sumner points, will always indicate whether L bears east or west of either Sumner point, and also whether it bears north or south. And the bearing of L once chosen, we can always find either of the two bow bearings by this formula:

(3) Bow bearing = bearing of Sumner line *minus* bearing of the second Sumner point S' from the first point S.

In using formula (3) it is allowable to increase the bearings of the Sumner lines by 360°, when necessary to make the subtractions possible, and if the formula brings out bow bearings larger than 180°, subtract them from 360°, and proceed as before.

It is also always desirable to draw a rough sketch for every intersection problem occurring on shipboard so as to guard against accidental large errors like 90° or 180° in obtaining the two bow bearings; and also to make sure that the latitude and longitude of the intersection point L are correctly computed with the traverse table.

The foregoing assumes that the ship did not move from the point L between the two sextant observations from which the two Sumner lines were calculated. This will rarely be the case, because it is very desirable that the two observations, if they are both sun observations, be separated by

three or four hours, if possible. The condition of an unmoving ship will occur only if she is a sailing vessel becalmed, or a steamer at anchor; or if the two observations are made at nearly the same time upon two different heavenly bodies, such as two stars.

High accuracy in the resulting "fix" (p. 53) of the ship will then be attained, if the azimuths of the two stars differ by about 90° at the time of observation. The same favorable condition will be secured if one of the observations is made upon a star near upper transit (pp. 89, 96), in the twilight just before sunrise or after sunset; and the other observation, at nearly the same time, upon the sun, when it is about 12° or 15° above the horizon.

But if the ship has traveled a considerable distance between the two observations, it is necessary to allow for such travel before calculating the intersection point. Suppose she has gone a distance D, upon a course C, by D. R., between the two observations. Then simply find from Tables 1 and 2 the difference of latitude and longitude corresponding to distance D and course C; and apply them as corrections to the latitude and longitude of the Sumner point belonging to the first observation. Everything else, including the bearing of the first Sumner line, remaining unchanged, the calculation then proceeds by Table 14, just as if the ship had not moved. The computed intersection point is then the ship's position at the time of the second sextant observation.

We shall now work some intersection examples.

Suppose we have two Sumner lines, as shown in the rough sketch, Fig. 19, taken on board a ship becalmed. The two sextant observations give:

	For One Sumner Point, S	For the Other Point, S'
lat.[1]:	42° 34′ N.	42° 50′ N.
long.:	35° 50′ W.	35° 36′ W.
bearing of Sumner line:	307°	93° (changed to 273°)

[1] As found on page 132.

The rough sketch, Fig. 19, having been made, and the two "bow bearings" marked with little circular arcs as shown, we call that one of the two Sumner points S', which has the larger bow bearing; and, for the point S', we change

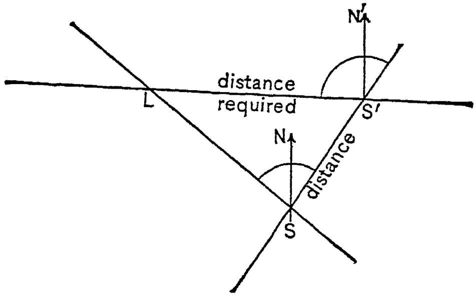

FIG. 19.—Rough Sketch of Sumner Intersection.

the bearing of the Sumner line from 93° to 180° + 93° = 273°, so as to count the bearing for that end of the line which is toward the intersection point L (p. 136). The other bearing, 307°, for the point S, is already correctly counted.

We now have, from the two Sumner point latitudes and longitudes: latitude difference = 16′; longitude difference = 14′; departure (Table 2, p. 174, for middle latitude 43°) = 10.2; and, for latitude difference = 16, departure = 10.2, we find (Table 1, p. 162), distance = 19, course = 32°. The distance between the two Sumner points is therefore 19 miles, and the bearing of S' from S is 32°.

Now we apply formula (3), page 136, and find:

Smaller bow bearing at $S = 307° - 32° = 275°$.
Larger bow bearing at $S' = 273° - 32° = 241°$.

Being larger than 180°, these must be subtracted from 360° (p. 136), giving:

Smaller bow bearing = 85°; Larger bow bearing = 119°.

Next we refer to Table 14, and find with the smaller bearing 85°, and the larger 119° the factor 1.78 (p. 322).

According to formula (1), page 135, we then have:

Required distance LS' = distance $SS' \times$ factor
$= 19 \times 1.78 = 33.8$ miles.

Therefore the position of the ship at L is distant 33.8 miles from S', and she bears 273°. With this distance and bearing or course angle, the traverse table (p. 154) gives: latitude = 1.8, departure = 33.8. For the departure 33.8, Table 2 gives, for the middle latitude 43° (p. 174), difference longitude = 46′.2. The bearing 273° showing that the intersection point L is N. and W. of S', we have:

Latitude of ship at L = 42° 50′ N. + 1′.8 = 42° 51′.8 N.
Longitude of ship at L = 35° 36′ W. + 46′.2 = 36° 22′ W.

As a second example take the following two Sumner lines, as shown in the rough sketch, Fig. 20. The two sextant observations give:

	For One Sumner Point, S	For the Other Point, S'
lat.:	14° 26′ N.	15° 30′ N.
long.:	77° 8′ W.	76° 22′.5 W.
bearing of line:	53°	135°

And suppose the ship, in the interval between the two sextant observations, has traveled a distance $D = 31$ miles, on course $C = 205°$. We must begin (p. 137) by shifting the first Sumner point S a distance D, on the course C. For this course and distance, we have (Table 1, p. 160): lat., 28′.1; dep., 13.1; diff. long., 13′.5 (Table 2, p. 168).

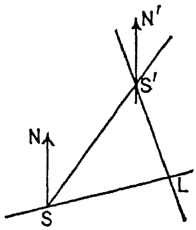

Fig. 20.—Rough Sketch of Sumner Intersection.

Therefore, the latitude and longitude of the first Sumner point must be corrected (p. 137) as follows:

For the point S, lat. = 14° 26′ N. − 28′.1 = 13° 58′ N.
long. = 77° 8′ W. + 13′.5 = 77° 21′.5 W.

Bearing (unchanged) = 53°.

We now have, for the two Sumner points: lat. diff., 92′;

long. diff., 59′; dep., 57.0 (p. 169); dist., 108 miles (p. 162); bearing of S' from S, 32°.

Now we have, by formula (3), page 136:

$$\text{Smaller bow bearing at } S = 53° - 32° = 21°.$$
$$\text{Larger bow bearing at } S' = 135° - 32° = 103°.$$

Table 14 (p. 319) gives the factor 0.36; so that the ship at L is distant from S' $108 \times .36 = 38.9$ miles, and bears 135°. For this distance and bearing we have (Table 1, p. 166), latitude = 27′.6; departure = 27.6; and longitude difference (Table 2, p. 168) = 28′.6. Finally, then, at the time of the second sextant observation, the ship at L was in latitude 15° 30′ N. − 27′.6 = 15° 2′.4 N.; and in longitude 76° 22′.5 W. − 28′.6 = 75° 54′ W.

CHAPTER X

A NAVIGATOR'S DAY AT SEA

THE present chapter contains a number of examples by means of which the reader can gain facility in the use of the methods set forth in the preceding pages.

The steam yacht *Nav* is bound from New York to Colon, and the captain plans to take his departure from the Sandy Hook Lightship, on Dec. 18, 1917, as early as possible in the morning.

The first bit of navigation, to be accomplished before the yacht leaves her anchorage in the "Horseshoe," is to ascertain by D. R. methods the proper course to steer from Sandy Hook. A glance at the track chart of the north Atlantic shows that she must go by way of Crooked Island Passage, and the Windward Passage between Cuba and Haiti. It is also apparent from the chart that the first land to be sighted among the islands is Watlings Island, and that the proper course should pass to the eastward of it.

The position of Sandy Hook Lightship [1] is lat. 40° 28′ N.; long. 73° 50′ W. Hinchinbroke Rock, at the southern end of Watlings Island, is in lat. 23° 57′ N.; long. 74° 28′ W. But the course should be shaped for a point about 12 miles east of Watlings Island, to be perfectly safe. The position of such a point is (approximately) lat. 23° 57′ N.; long. 74° 15′ W.[2]

[1] There is an excellent list of latitudes and longitudes in Bowditch's "Navigator."

[2] The difference between this longitude and that of Hinchinbroke Rock is 13′; but 13′ here corresponds to about 12 miles, on account of Table 2.

ABSTRACT OF LOG. Steam Yacht *Nav*, Dec. 18, 1917

		Patent Log	Compass Course	True Course
7:02 A.M.	Took departure from Sandy Hook Lightship.........	26.2	S.	188°
7:21	Sunrise, observed azimuth	31.0	S.	188°
8:00		41.0	S.	188°
9:00		57.2	S.	188°
9:36	Bow bearing, Barnegat....	67.0	S.	188°
9:42	Altitude and azimuth.....	69.1	S.	188°
9:57	Beam bearing, Barnegat... (fix, lat. 39° 45′ N.; long. 73° 59′ W.)	72.5	S.	188°
10:00		73.4	S.	188°
10:07	Changed course...........	75.3	S.½E.	182°
11:00		88.7	S.½E.	182°
11:42	Ex-mer. obs'n lat. 39° 19′; D. R. long. 73° 58′.....	98.5	S.½E.	182°
12:00		102.6	S.½E.	182°
1:00 P.M.		117.7	S.½E.	182°
2:00		133.0	S.½E.	182°
3:00		149.0	S.½E.	182°
4:00		163.8	S.½E.	182°
4:12	Alt. and az., fix, lat. 38° 11′; long. 73° 54′..........	166.9	S.½E.	182°
5:00		182.0	S.½E.	182°
6:00		197.2	S.¾E.	182½°

By the method of page 20, the course from Sandy Hook Lightship should be 181°, and the distance is 990 miles. These numbers, and all subsequent numbers in the present chapter, should be verified by the reader.

The distance being quite large, it is well to check it by the logarithmic method, page 33. The result by this method is: course 181° 14′, distance 991.7 miles.

The chart also shows that this course will carry the yacht very near Barnegat Light, on the coast of New Jersey. The position of this light is lat. 39° 46′ N.; long. 74° 6′ W. The captain decides that it will be well to plan passing this light

at about 5 miles' distance. The position of a point 5 miles east of Barnegat Light is lat. 39° 46′ N., long. 73° 59′ W. The course and distance to this point from Sandy Hook Ship are 189° and 42.5 miles. This course is so nearly the same as the course to Watlings Island that the captain decides to steer the 189° course.

All this work must be complete before reaching Sandy Hook, for the course from the lightship must be ready for the quartermaster before the lightship is passed. And there is still more preliminary work. For the courses calculated above are true courses (p. 43) and the quartermaster must have the compass course, so that he may be able to steer the yacht. The method of calculating the compass course from the true course is given on page 48; and in applying it the captain must have his deviation tables at hand. We shall assume that the tables printed on pages 48 and 49 were the ones furnished by the compass adjuster for the present voyage.

An examination of the Atlantic track chart shows that in the vicinity of Sandy Hook, the variation, V, is 10° W., or $-10°$. By formula (3) (p. 49), we then have, since the true course T is 189°:

$$\text{Magnetic course} = M = T - V = 189° - (-10°) = 199°.$$

The second deviation table (p. 49) shows that when the magnetic course (or magnetic bearing of ship's head) is 199°, the deviation, D, is $+18°$. Then, with $V = -10°$, $D = 18°$, formula (1), page 45, gives:

$$\text{Compass error} = E = V + D = -10° + 18° = +8°.$$

And from formula (2), page 45:

$$\text{Compass course } C = T - E = 189° - 8° = 181°;$$

and so the yacht must be steered on a 181° compass course for Barnegat. But the quartermaster is to steer by "points" so that the course nearest the 181° course is due south. The captain decides to have the yacht steered due south by

compass, and is prepared to give the quartermaster his orders as soon as Sandy Hook Lightship shall be reached.

The foregoing preliminary work having been completed the previous day, the anchor is tripped at the Horseshoe about an hour before daylight on Dec. 18, the weather being fine, sea smooth, and wind light from the northwest. The lightship is reached and passed at 7 : 02 A.M., ship's time, civil reckoning, the ship then taking her departure. At that moment, the patent log is read, and found to register 26.2 miles. The quartermaster gets his orders to steer south; and *all* the above facts are duly recorded in the log-book. And at every hour thereafter, 8, 9, 10, etc., a similar record must be made in the log-book.

The next event is sunrise, which occurs at 7 : 21, very soon after leaving the lightship. The sun's compass bearing can then be very conveniently observed, and will furnish an excellent check on the compass adjuster. This observation was made at 7 : 21 A.M., ship's time, civil reckoning, corresponding to $19^h\ 21^m$, Dec. 17, ship's apparent time, astronomic reckoning; and the sun's bearing or azimuth was 113° by compass. This was entered in the log-book, and at the same time the patent log was read, and found to be 31.0 miles.

To check the deviation table, the procedure was then as follows:

By patent log the yacht had proceeded from the lightship a distance of $31.0 - 26.2 = 4.8$ miles, on a compass course of 180°, or true course of 188°; by D. R., she had therefore reached the position lat. 40° 23′ N.; long. 73° 51′ W. The sun's declination, from the almanac, is − 23° 23′, and the (approximate[1]) T (p. 100) is $19^h\ 21^m$. The sun's true azimuth is found from Table 11 to be 121°; and in using the table for this purpose take the altitude of the sun, for the

[1] If there is any chance of this T being much in error, the captain's watch, by which the observation is timed, must be compared with the chronometer. See p. 94.

moment of sunrise, to be 0°. The observed compass azimuth having been 113°, formula (2), page 45, gave $E = T - C = 121° - 113° = +8°$. Then from formula (1), page 45, $D = E - V = +8° - (-10°) = +18°$. As expected, this deviation agrees with the deviation table, which would not be likely to go wrong so soon after the beginning of a voyage.

At 8 A.M. the patent log read 41.0; and at 9 A.M., 57.2. The course was still S. by compass, or 188°, true course.

At 9:24 Barnegat Light was sighted by the lookout, and the mate was ordered to take bow-and-beam bearings (p. 55) upon it.

At 9:36, the light bore 225° by compass, or 45° from the bow; patent log, 67.0.

At $9^h\ 42^m\ 28^s$ by his watch the captain took the altitude of the sun's lower limb with the sextant, and found it to be 18° 51′. Index correction was + 3′, and height of eye, 15 feet. C. – W. was $4^h\ 51^m\ 50^s$; and the chr. correction by the rate card was 4^s, slow. Patent log, 69.1. At 9:45 by the watch, the sun's azimuth was again observed with pelorus, and found to be 137°, compass bearing. It was intended to work a Sumner line from the altitude by Kelvin's table; and the pelorus observation was made because the sun's true azimuth always comes out as a by-product, when Kelvin's table is used, and so it is just as well to have another check on the deviation table. This is the peculiar advantage of Kelvin's table. Without any additional calculations, the compass is always checked up on the very course the ship is steering. This is just what the good navigator wants.

The observations could not be worked up at once, because the captain wished to see the result of the mate's bow-and-beam bearings. At 9:57 by the watch, Barnegat bore abeam, on the starboard hand, or 270° by compass, the yacht being still on the 180° compass course. Patent log now 72.5.

Between the bow-and-beam bearings the run by log was $72.5 - 67 = 5.5$ miles. Therefore the yacht is now 5.5 miles from Barnegat Light, and the compass bearing of the light is 270°. The compass error being $+ 8°$, the true bearing of the light is 278°; and the bearing of the yacht from the light is the former bearing reversed, or $278° - 180° = 98°$, true. From this comes an accurate and complete position of the yacht. Barnegat Light is in lat. 39° 46′ N.; long. 74° 6′ W. The yacht, 5.5 miles away on the bearing 98°, must, by traverse table, be in lat. 39° 45′ N.; long. 73° 59′ W.

At 10 A.M., the log was 73.4, course 188°, true.

Now the captain prepared to shape a new course to be followed from the Barnegat bow-and-beam bearing "fix" in the above lat. 39° 45′ N.; long. 73° 59′ W., at 9:57.

Allowing ten minutes to work up the new course, the captain plans to change course at 10:07. At that time the ship, on her course of 188°, will be (at 15-knot speed) 2′.5 S. and practically 0′ W. of the Barnegat position. So the course will be changed when the yacht is in lat. 39° 42′ N.; long. 73° 59′ W., at 10:07. The course and distance from there to the point 12 miles east of Hinchinbroke Rock are: distance, 945 miles; course, 181°, true, or 173° by compass.

Therefore, by the table on page 52, the quartermaster gets the new course S.½E. by compass, at 10:07. This corresponds to 174° by compass, or 182° true course; and at 10:07, when the course was changed, the patent log read 75.3.

Now the Sumner line, from the observation at $9^h\ 42^m\ 28^s$ by the watch, was worked by Kelvin's table; and the result was:

Sumner point is in lat. 39° 50′ N.; long. 73° 56′ W.; bearing of Sumner line 237°.

It is necessary, as a check, to ascertain whether this Sumner line passes through the position obtained for the ship by the Barnegat bearings. Before doing this, the Sumner point must be shifted by the method of page 137, to allow for

the motion of the yacht between 9:42, when the sextant observation was made, and 9:57, when Barnegat bore abeam. The difference is 15 minutes, and in that time the ship moved south 3.4 miles by the patent log and an insignificant distance west.

Therefore the corrected Sumner data are:

Sumner point is in lat. 39° 46′.6 N.; long. 73° 56′ W.; bearing of Sumner line 237°.

If everything fits, this Sumner line must pass through the Barnegat "fix" of the yacht in lat. 39° 45′ N.; long. 73° 59′ W., because the yacht must have been somewhere on the line.

The traverse table shows that the bearing of a line passing the Sumner point and the yacht's position is 235°, differing only 2° from the Sumner line bearing; so this check is satisfactory. But a better way to check this matter is to determine the yacht's position from the intersection of two lines, one of which is the Sumner line, and the other the beam bearing of Barnegat Light. This can be done by the method of page 133. The data of the problem are:

Sumner point: lat. 39° 46′.6 N.
long. 73° 56′ W.
Line bears 237°
Barnegat Light: lat. 39° 46′ N.
long. 74° 6′ W.
Line bears 98°

We shall call Barnegat Light S'; and then formula (3), page 136, gives, for the two bow bearings:

At Sumner point, S, $237° - 266° = 29°$.
At Barnegat, S', $98° - 266° = 168°$.

For these two bearings, Table 14 gives the factor 0.74, and the yacht is placed 6 miles from Barnegat, on the 98° bearing. The bow-and-beam observations gave 5.5 miles, so the check by the Sumner line is excellent.

It remains for the captain to utilize the azimuth observa-

tion made at 9:45. The bearing of the Sumner line was 237°, and therefore the sun's true azimuth was 147°. The observed azimuth, by pelorus (p. 145), was 137°. The compass error was therefore + 10°. The variation being − 10°, the deviation by formula (1), page 45, is $D = 10° - (-10°) = +20°$.

On page 143 we found that the deviation table made this deviation + 18°; so that the table appears to require a correction of + 2°. The captain decides not to correct the table for the present, unless later azimuth observations shall confirm it, especially as the sunrise observation showed the adjuster's results to be correct. Azimuth observations made when the sun is high in the sky are not quite as reliable as sunrise ones. Moreover, the observation was made at 9:45, whereas the altitude observation, for which the true azimuth was calculated with Kelvin's table, was made at 9:42, so that the true azimuth must have been in error by the sun's azimuth change in three minutes. This could have been avoided by giving the mate orders to observe the azimuth at about the same moment when the captain took the altitude. Or, the sun's azimuth change in three minutes might be taken from the azimuth table, and the computed true azimuth duly corrected.

At 11 the log read 88.7, and the course was S.½E. by compass, or 182°, true.

At about 11:30, the weather showing signs of becoming thick, no preparations were made for a noon-sight by the method of page 86; and rather than take the risk of losing his noon observation altogether, the captain took an ex-meridian altitude at $11^h\ 42^m\ 0^s$ by his watch; log was 98.5; the sextant reading 26° 55′; index + 3′; height of eye 15 ft.; C. − W. was now $4^h\ 51^m\ 42^s$; and chronometer slow 4^s.

The observation was worked by Kelvin's table, and gave the Sumner point in lat. 39° 20′ N.; long. 73° 40′ W.; bearing of Sumner line 86°. Figure 21 is a rough sketch of this Sumner line. It is very nearly horizontal; had the observation been

made at noon precisely, it would have been perfectly horizontal.

It would now have been possible to move up the Sumner line observed at 9 : 42, and obtain an intersection to fix the position of the yacht. But this did not seem necessary to the captain, because of the beam bearing obtained at Barnegat at 9 : 57, which gave a good fix.

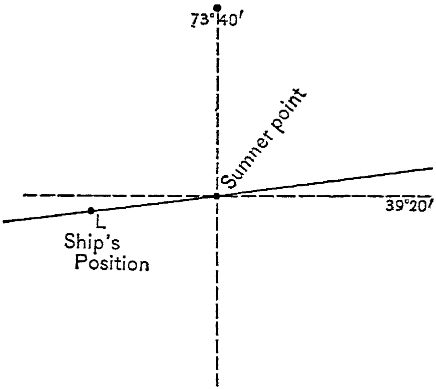

Fig. 21.—Sumner Line from ex-Meridian Observation.

And the present Sumner line being so nearly horizontal, it is not necessary to know the longitude very accurately to obtain an exact latitude. The longitude by D. R. is sufficient, and it is 73° 58′ W. The difference between this longitude and that of the Sumner point (73° 40′) is 18′; and the ship at *L* (fig. 21) bears 180° + 86° = 266° from the Sumner point. Table 2 gives the dep. 14.0 for long. diff. 18′, in lat. 39°. And for course 266°, dep. 14.0, we find in Table 1, lat. diff. 1′.0, so the yacht's latitude is 1′ less than that of the Sumner point, and is therefore 39° 19′. This happens to be in exact accord with the D. R. latitude, which was also 39° 19′. This was perfectly satisfactory, and the captain decided to carry this Sumner line forward for an intersection, in case he should obtain an observation in the afternoon.

At 12, the patent log read 102.6, course S.½E., 182° true; D. R. lat. 39° 15′; long. 73° 58′; distance to Watlings Island 918 miles.

Had the yacht been on a course other than almost due south, it would have been necessary to set the watch and the

cabin clock to ship's apparent time. In fact, some navigators set their watches to ship's apparent time before every observation (p. 94):

at 1, log read 117.7, misty,
at 2, log read 133.0, misty,
at 3, log read 149.0 misty,
at 4, log read 163.8, clearing.

At 4^h 12^m 18^s by the watch, the weather having cleared, the altitude of the sun was found to be 4° 38′; index + 4′; eye 15 ft.; C. – W. 4^h 51^m 50^s; chronometer slow 4^s; log 166.9. Sun's azimuth, observed by the mate at the same time, came out 224° by compass.

This observation was worked for a Sumner line by the Kelvin table, and gave:

Position of Sumner point lat. 38° 6′ N.; long. 73° 49′ W.; bearing of line 145°; azimuth of sun 235°.

The Sumner line obtained at 11^h 42^m 0^s was brought up to the time of the present observation by D. R. (p. 137), giving: position of 11:42 Sumner point, after moving it, lat. 38° 12′ N.; long. 73° 43′ W.; bearing of the line 86°. Both lines were then sketched, as shown in Fig. 22. The point S is the (moved) Sumner point from the 11:42 observation, S' that from the 4:12 observation. The intersection point L is the position of the ship at 4:12, and it came out (p. 134): lat. 38° 11′ N.; long. 73° 54′ W. The position brought up by D. R. from 11:42 was: lat. 38° 11′; long. 74° 1′; so that there has been an easterly set of the current, amounting to 7′ of longitude in 4½ hours. The sun's true azimuth at 4:12 was 235°, from the Kelvin table; and the pelorus observation gave 224°. The compass error was therefore

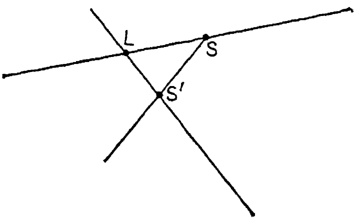

FIG. 22.—Rough Sketch of Sumner Line Intersection.

$+ 11°$. The variation being $- 10°$, the deviation must be $D = 11° - (- 10° =) + 21°$. The deviation table made this deviation $+ 18°$, so that table seems to require a correction of $+ 3°$. The pelorus observation of 9 : 45 gave a correction of $+ 2°$ for the deviation table; and as this is now apparently confirmed, the captain decides to examine the chart again, before finally shaping course for the night, to see if the yacht has not perhaps moved into a region where the variation is different from the Sandy Hook variation so far used.

At 5 the log read 182.0, course was still 182° true.

The captain now prepared to shape the course for the night, and to change his course, if necessary, at 6 : 00. His first step was to obtain the D. R. position at 6 : 00, starting from the observed position at 4 : 12. This gave position at 6 : 00, by D. R.: lat. 37° 41′; long. 73° 55′. The easterly current[1] of about 2′ per hour set the yacht farther east about 3′ between 4 : 12 and 6 : 00. Therefore he took the D. R. position at 6 : 00 to be lat. 37° 41′; long. 73° 52′. The position of the point of destination, 12 miles east of Watlings Island, is still: lat. 23° 57′; long. 74° 15′. The true course and distance to that point from the yacht's 6 : 00 position is therefore, by traverse table: course $181\frac{1}{2}°$; dist. 824 miles.

A further examination of the track chart shows that the variation, which was $- 10°$ at Sandy Hook, is now $- 8°$. The compass error, from the last pelorus observation, was $+ 11°$. Consequently, by the pelorus observation, the compass course for the night should be $181\frac{1}{2}° - 11° = 170\frac{1}{2}°$, or S.$\frac{3}{4}$E. (see the Table on p. 52). Furthermore, the variation being now $- 8°$ and the error $+ 11°$ makes the deviation $D = E - V = + 11° - (- 8°) = + 19°$. The compass adjuster's deviation of $+ 18°$ is therefore vindicated, and the compass course S.$\frac{3}{4}$E. can be set for the night.

At 6 the log read 197.2, course S.$\frac{3}{4}$E., or $182\frac{1}{2}°$ true.

[1] Doubtless the Gulf Stream.

In conclusion, the captain of the *Nav* hopes he has been able to make his imagined proceedings clear enough to help the young navigator in planning his own first day's work at sea. May it be the first of many happy and successful days. And let him not forget, when attempting to verify the various calculations and problems of the *Nav*, that every observation in this book has been prepared by calculation, and none is the result of actual sextant observing. Should inconsistencies or errors be found by any young navigator, it is hoped that he will make them known so that they may be corrected, in case the *Nav* shall be required to make another voyage in a second edition.

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PUBLISHERS' NOTE

Table 3, Number Logarithms, has been reprinted from "The Macmillan Logarithmic and Trigonometric Tables," New York, 1917.

Dist.	1° (179°, 181°, 359°)		2° (178°, 182°, 358°)		¼ Pt. 3° (177°, 183°, 357°)		4° (176°, 184°, 356°)		5° (175°, 185°, 355°)		½ Pt. 6° (174°, 186°, 354°)		7° (173°, 187°, 353°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	1.0	0.0	1.0	0.0	1.0	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0	0.1
2	2.0	0.0	2.0	0.1	2.0	0.1	2.0	0.1	2.0	0.2	2.0	0.2	2.0	0.2
3	3.0	0.1	3.0	0.1	3.0	0.2	3.0	0.2	3.0	0.3	3.0	0.3	3.0	0.4
4	4.0	0.1	4.0	0.1	4.0	0.2	4.0	0.3	4.0	0.3	4.0	0.4	4.0	0.5
5	5.0	0.1	5.0	0.2	5.0	0.3	5.0	0.3	5.0	0.4	5.0	0.5	5.0	0.6
6	6.0	0.1	6.0	0.2	6.0	0.3	6.0	0.4	6.0	0.5	6.0	0.6	6.0	0.7
7	7.0	0.1	7.0	0.2	7.0	0.4	7.0	0.5	7.0	0.6	7.0	0.7	6.9	0.9
8	8.0	0.1	8.0	0.3	8.0	0.4	8.0	0.6	8.0	0.7	8.0	0.8	7.9	1.0
9	9.0	0.2	9.0	0.3	9.0	0.5	9.0	0.6	9.0	0.8	9.0	0.9	8.9	1.1
10	10.0	0.2	10.0	0.3	10.0	0.5	10.0	0.7	10.0	0.9	9.9	1.0	9.9	1.2
11	11.0	0.2	11.0	0.4	11.0	0.6	11.0	0.8	11.0	1.0	10.9	1.1	10.9	1.3
12	12.0	0.2	12.0	0.4	12.0	0.6	12.0	0.8	12.0	1.0	11.9	1.3	11.9	1.5
13	13.0	0.2	13.0	0.5	13.0	0.7	13.0	0.9	13.0	1.1	12.9	1.4	12.9	1.6
14	14.0	0.2	14.0	0.5	14.0	0.7	14.0	1.0	13.9	1.2	13.9	1.5	13.9	1.7
15	15.0	0.3	15.0	0.5	15.0	0.8	15.0	1.0	14.9	1.3	14.9	1.6	14.9	1.8
16	16.0	0.3	16.0	0.6	16.0	0.8	16.0	1.1	15.9	1.4	15.9	1.7	15.9	1.9
17	17.0	0.3	17.0	0.6	17.0	0.9	17.0	1.2	16.9	1.5	16.9	1.8	16.9	2.1
18	18.0	0.3	18.0	0.6	18.0	0.9	18.0	1.3	17.9	1.6	17.9	1.9	17.9	2.2
19	19.0	0.3	19.0	0.7	19.0	1.0	19.0	1.3	18.9	1.7	18.9	2.0	18.9	2.3
20	20.0	0.3	20.0	0.7	20.0	1.0	20.0	1.4	19.9	1.7	19.9	2.1	19.9	2.4
21	21.0	0.4	21.0	0.7	21.0	1.1	20.9	1.5	20.9	1.8	20.9	2.2	20.8	2.6
22	22.0	0.4	22.0	0.8	22.0	1.2	21.9	1.5	21.9	1.9	21.9	2.3	21.8	2.7
23	23.0	0.4	23.0	0.8	23.0	1.2	22.9	1.6	22.9	2.0	22.9	2.4	22.8	2.8
24	24.0	0.4	24.0	0.8	24.0	1.3	23.9	1.7	23.9	2.1	23.9	2.5	23.8	2.9
25	25.0	0.4	25.0	0.9	25.0	1.3	24.9	1.7	24.9	2.2	24.9	2.6	24.8	3.0
26	26.0	0.5	26.0	0.9	26.0	1.4	25.9	1.8	25.9	2.3	25.9	2.7	25.8	3.2
27	27.0	0.5	27.0	0.9	27.0	1.4	26.9	1.9	26.9	2.4	26.9	2.8	26.8	3.3
28	28.0	0.5	28.0	1.0	28.0	1.5	27.9	2.0	27.9	2.4	27.8	2.9	27.8	3.4
29	29.0	0.5	29.0	1.0	29.0	1.5	28.9	2.0	28.9	2.5	28.8	3.0	28.8	3.5
30	30.0	0.5	30.0	1.0	30.0	1.6	29.9	2.1	29.9	2.6	29.8	3.1	29.8	3.7
31	31.0	0.5	31.0	1.1	31.0	1.6	30.9	2.2	30.9	2.7	30.8	3.2	30.8	3.8
32	32.0	0.6	32.0	1.1	32.0	1.7	31.9	2.2	31.9	2.8	31.8	3.3	31.8	3.9
33	33.0	0.6	33.0	1.2	33.0	1.7	32.9	2.3	32.9	2.9	32.8	3.4	32.8	4.0
34	34.0	0.6	34.0	1.2	34.0	1.8	33.9	2.4	33.9	3.0	33.8	3.6	33.7	4.1
35	35.0	0.6	35.0	1.2	35.0	1.8	34.9	2.4	34.9	3.1	34.8	3.7	34.7	4.3
36	36.0	0.6	36.0	1.3	36.0	1.9	35.9	2.5	35.9	3.1	35.8	3.8	35.7	4.4
37	37.0	0.6	37.0	1.3	36.9	1.9	36.9	2.6	36.9	3.2	36.8	3.9	36.7	4.5
38	38.0	0.7	38.0	1.3	37.9	2.0	37.9	2.7	37.9	3.3	37.8	4.0	37.7	4.6
39	39.0	0.7	39.0	1.4	38.9	2.0	38.9	2.7	38.9	3.4	38.8	4.1	38.7	4.8
40	40.0	0.7	40.0	1.4	39.9	2.1	39.9	2.8	39.8	3.5	39.8	4.2	39.7	4.9
41	41.0	0.7	41.0	1.4	40.9	2.1	40.9	2.9	40.8	3.6	40.8	4.3	40.7	5.0
42	42.0	0.7	42.0	1.5	41.9	2.2	41.9	2.9	41.8	3.7	41.8	4.4	41.7	5.1
43	43.0	0.8	43.0	1.5	42.9	2.3	42.9	3.0	42.8	3.7	42.8	4.5	42.7	5.2
44	44.0	0.8	44.0	1.5	43.9	2.3	43.9	3.1	43.8	3.8	43.8	4.6	43.7	5.4
45	45.0	0.8	45.0	1.6	44.9	2.4	44.9	3.1	44.8	3.9	44.8	4.7	44.7	5.5
46	46.0	0.8	46.0	1.6	45.9	2.4	45.9	3.2	45.8	4.0	45.7	4.8	45.7	5.6
47	47.0	0.8	47.0	1.6	46.9	2.5	46.9	3.3	46.8	4.1	46.7	4.9	46.6	5.7
48	48.0	0.8	48.0	1.7	47.9	2.5	47.9	3.3	47.8	4.2	47.7	5.0	47.6	5.8
49	49.0	0.9	49.0	1.7	48.9	2.6	48.9	3.4	48.8	4.3	48.7	5.1	48.6	6.0
50	50.0	0.9	50.0	1.7	49.9	2.6	49.9	3.5	49.8	4.4	49.7	5.2	49.6	6.1
100	100.0	1.7	99.9	3.5	99.9	5.2	99.8	7.0	99.6	8.7	99.5	10.5	99.3	12.2
200	200.0	3.5	199.9	7.0	199.7	10.5	199.5	14.0	199.2	17.4	198.9	20.9	198.5	24.4
300	300.0	5.2	299.8	10.5	299.6	15.7	299.3	20.9	298.9	26.1	298.4	31.4	297.8	36.6
400	399.9	7.0	399.8	13.9	399.4	20.9	399.0	27.9	398.5	34.9	397.8	41.8	397.0	48.7
500	499.9	8.8	499.7	17.4	499.3	26.2	498.8	34.8	498.1	43.6	497.3	52.3	496.3	61.0
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(91°, 269°, 271°) 89°		(92°, 268°, 272°) 88°		(93°, 267°, 273°) 7¾ Pt. 87°		(94°, 266°, 274°) 86°		(95°, 265°, 275°) 85°		(96°, 264°, 276°) 7½ Pt. 84°		(97°, 263°, 277°) 83°	

Dist.	1° (179°, 181°, 359°)		2° (178°, 182°, 358°)		¼ Pt. 3° (177°, 183°, 357°)		4° (176°, 184°, 356°)		5° (175°, 185°, 355°)		½ Pt. 6° (174°, 186°, 354°)		7° (173°, 187°, 353°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	51.0	0.9	51.0	1.8	50.9	2.7	50.9	3.6	50.8	4.4	50.7	5.3	50.6	6.2
52	52.0	0.9	52.0	1.8	51.9	2.7	51.9	3.6	51.8	4.5	51.7	5.4	51.6	6.3
53	53.0	0.9	53.0	1.8	52.9	2.8	52.9	3.7	52.8	4.6	52.7	5.5	52.6	6.5
54	54.0	0.9	54.0	1.9	53.9	2.8	53.9	3.8	53.8	4.7	53.7	5.6	53.6	6.6
55	55.0	1.0	55.0	1.9	54.9	2.9	54.9	3.8	54.8	4.8	54.7	5.7	54.6	6.7
56	56.0	1.0	56.0	2.0	55.9	2.9	55.9	3.9	55.8	4.9	55.7	5.9	55.6	6.8
57	57.0	1.0	57.0	2.0	56.9	3.0	56.9	4.0	56.8	5.0	56.7	6.0	56.6	6.9
58	58.0	1.0	58.0	2.0	57.9	3.0	57.9	4.0	57.8	5.1	57.7	6.1	57.6	7.1
59	59.0	1.0	59.0	2.1	58.9	3.1	58.9	4.1	58.8	5.1	58.7	6.2	58.6	7.2
60	60.0	1.0	60.0	2.1	59.9	3.1	59.9	4.2	59.8	5.2	59.7	6.3	59.6	7.3
61	61.0	1.1	61.0	2.1	60.9	3.2	60.9	4.3	60.8	5.3	60.7	6.4	60.5	7.4
62	62.0	1.1	62.0	2.2	61.9	3.2	61.8	4.3	61.8	5.4	61.7	6.5	61.5	7.6
63	63.0	1.1	63.0	2.2	62.9	3.3	62.8	4.4	62.8	5.5	62.7	6.6	62.5	7.7
64	64.0	1.1	64.0	2.2	63.9	3.3	63.8	4.5	63.8	5.6	63.6	6.7	63.5	7.8
65	65.0	1.1	65.0	2.3	64.9	3.4	64.8	4.5	64.8	5.7	64.6	6.8	64.5	7.9
66	66.0	1.2	66.0	2.3	65.9	3.5	65.8	4.6	65.7	5.8	65.6	6.9	65.5	8.0
67	67.0	1.2	67.0	2.3	66.9	3.5	66.8	4.7	66.7	5.8	66.6	7.0	66.5	8.2
68	68.0	1.2	68.0	2.4	67.9	3.6	67.8	4.7	67.7	5.9	67.6	7.1	67.5	8.3
69	69.0	1.2	69.0	2.4	68.9	3.6	68.8	4.8	68.7	6.0	68.6	7.2	68.5	8.4
70	70.0	1.2	70.0	2.4	69.9	3.7	69.8	4.9	69.7	6.1	69.6	7.3	69.5	8.5
71	71.0	1.2	71.0	2.5	70.9	3.7	70.8	5.0	70.7	6.2	70.6	7.4	70.5	8.7
72	72.0	1.3	72.0	2.5	71.9	3.8	71.8	5.0	71.7	6.3	71.6	7.5	71.5	8.8
73	73.0	1.3	73.0	2.5	72.9	3.8	72.8	5.1	72.7	6.4	72.6	7.6	72.5	8.9
74	74.0	1.3	74.0	2.6	73.9	3.9	73.8	5.2	73.7	6.4	73.6	7.7	73.4	9.0
75	75.0	1.3	75.0	2.6	74.9	3.9	74.8	5.2	74.7	6.5	74.6	7.8	74.4	9.1
76	76.0	1.3	76.0	2.7	75.9	4.0	75.8	5.3	75.7	6.6	75.6	7.9	75.4	9.3
77	77.0	1.3	77.0	2.7	76.9	4.0	76.8	5.4	76.7	6.7	76.6	8.0	76.4	9.4
78	78.0	1.4	78.0	2.7	77.9	4.1	77.8	5.4	77.7	6.8	77.6	8.2	77.4	9.5
79	79.0	1.4	79.0	2.8	78.9	4.1	78.8	5.5	78.7	6.9	78.6	8.3	78.4	9.6
80	80.0	1.4	80.0	2.8	79.9	4.2	79.8	5.6	79.7	7.0	79.6	8.4	79.4	9.7
81	81.0	1.4	81.0	2.8	80.9	4.2	80.8	5.7	80.7	7.1	80.6	8.5	80.4	9.9
82	82.0	1.4	82.0	2.9	81.9	4.3	81.8	5.7	81.7	7.1	81.6	8.6	81.4	10.0
83	83.0	1.4	82.9	2.9	82.9	4.3	82.8	5.8	82.7	7.2	82.5	8.7	82.4	10.1
84	84.0	1.5	83.9	2.9	83.9	4.4	83.8	5.9	83.7	7.3	83.5	8.8	83.4	10.2
85	85.0	1.5	84.9	3.0	84.9	4.4	84.8	5.9	84.7	7.4	84.5	8.9	84.4	10.4
86	86.0	1.5	85.9	3.0	85.9	4.5	85.8	6.0	85.7	7.5	85.5	9.0	85.4	10.5
87	87.0	1.5	86.9	3.0	86.9	4.6	86.8	6.1	86.7	7.6	86.5	9.1	86.4	10.6
88	88.0	1.5	87.9	3.1	87.9	4.6	87.8	6.1	87.7	7.7	87.5	9.2	87.3	10.7
89	89.0	1.6	88.9	3.1	88.9	4.7	88.8	6.2	88.7	7.8	88.5	9.3	88.3	10.8
90	90.0	1.6	89.9	3.1	89.9	4.7	89.8	6.3	89.7	7.8	89.5	9.4	89.3	11.0
91	91.0	1.6	90.9	3.2	90.9	4.8	90.8	6.3	90.7	7.9	90.5	9.5	90.3	11.1
92	92.0	1.6	91.9	3.2	91.9	4.8	91.8	6.4	91.6	8.0	91.5	9.6	91.3	11.2
93	93.0	1.6	92.9	3.2	92.9	4.9	92.8	6.5	92.6	8.1	92.5	9.7	92.3	11.3
94	94.0	1.6	93.9	3.3	93.9	4.9	93.8	6.6	93.6	8.2	93.5	9.8	93.3	11.5
95	95.0	1.7	94.9	3.3	94.9	5.0	94.8	6.6	94.6	8.3	94.5	9.9	94.3	11.6
96	96.0	1.7	95.9	3.4	95.9	5.0	95.8	6.7	95.6	8.4	95.5	10.0	95.3	11.7
97	97.0	1.7	96.9	3.4	96.9	5.1	96.8	6.8	96.6	8.5	96.5	10.1	96.3	11.8
98	98.0	1.7	97.9	3.4	97.9	5.1	97.8	6.8	97.6	8.5	97.5	10.2	97.3	11.9
99	99.0	1.7	98.9	3.5	98.9	5.2	98.8	6.9	98.6	8.6	98.5	10.3	98.3	12.1
100	100.0	1.7	99.9	3.5	99.9	5.2	99.8	7.0	99.6	8.7	99.5	10.5	99.3	12.2
600	599.9	10.5	599.6	20.9	599.2	31.4	598.6	41.9	597.7	52.3	596.7	62.7	595.5	73.1
700	699.8	12.2	699.5	24.4	699.0	36.6	698.2	48.8	697.2	61.0	696.1	73.2	694.9	85.3
800	799.8	14.0	799.5	27.9	798.9	41.9	798.0	55.8	796.9	69.7	795.6	83.6	794.1	97.5
900	899.7	15.7	899.3	31.4	898.6	47.1	897.6	62.8	896.4	78.4	895.0	94.1	893.3	109.6
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(91°, 269°, 271°) 89°		(92°, 268° 272°) 88°		(93°, 267°, 273°) 7¾ Pt. 87°		(94°, 266°, 274°) 86°		(95°, 265°, 275°) 85°		(96°, 264°, 276°) 7½ Pt. 84°		(97°, 263°, 277°) 83°	

Dist.	¾ Pt. **8°** (172°, 188°, 352°)		**9°** (171°, 189°, 351°)		**10°** (170°, 190°, 350°)		1 Pt. **11°** (169°, 191°, 349°)		**12°** (168°, 192°, 348°)		**13°** (167°, 193°, 347°)		1¼ Pt. **14°** (166°, 194°, 346°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	1.0	0.1	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2
2	2.0	0.3	2.0	0.3	2.0	0.3	2.0	0.4	2.0	0.4	1.9	0.4	1.9	0.5
3	3.0	0.4	3.0	0.5	3.0	0.5	2.9	0.6	2.9	0.6	2.9	0.7	2.9	0.7
4	4.0	0.6	4.0	0.6	3.9	0.7	3.9	0.8	3.9	0.8	3.9	0.9	3.9	1.0
5	5.0	0.7	4.9	0.8	4.9	0.9	4.9	1.0	4.9	1.0	4.9	1.1	4.9	1.2
6	5.9	0.8	5.9	0.9	5.9	1.0	5.9	1.1	5.9	1.2	5.8	1.3	5.8	1.5
7	6.9	1.0	6.9	1.1	6.9	1.2	6.9	1.3	6.8	1.5	6.8	1.6	6.8	1.7
8	7.9	1.1	7.9	1.3	7.9	1.4	7.9	1.5	7.8	1.7	7.8	1.8	7.8	1.9
9	8.9	1.3	8.9	1.4	8.9	1.6	8.8	1.7	8.8	1.9	8.8	2.0	8.7	2.2
10	9.9	1.4	9.9	1.6	9.8	1.7	9.8	1.9	9.8	2.1	9.7	2.2	9.7	2.4
11	10.9	1.5	10.9	1.7	10.8	1.9	10.8	2.1	10.8	2.3	10.7	2.5	10.7	2.7
12	11.9	1.7	11.9	1.9	11.8	2.1	11.8	2.3	11.7	2.5	11.7	2.7	11.6	2.9
13	12.9	1.8	12.8	2.0	12.8	2.3	12.8	2.5	12.7	2.7	12.7	2.9	12.6	3.1
14	13.9	1.9	13.8	2.2	13.8	2.4	13.7	2.7	13.7	2.9	13.6	3.1	13.6	3.4
15	14.9	2.1	14.8	2.3	14.8	2.6	14.7	2.9	14.7	3.1	14.6	3.4	14.6	3.6
16	15.8	2.2	15.8	2.5	15.8	2.8	15.7	3.1	15.7	3.3	15.6	3.6	15.5	3.9
17	16.8	2.4	16.8	2.7	16.7	3.0	16.7	3.2	16.6	3.5	16.6	3.8	16.5	4.1
18	17.8	2.5	17.8	2.9	17.7	3.1	17.7	3.4	17.6	3.7	17.5	4.0	17.5	4.4
19	18.8	2.6	18.8	3.0	18.7	3.3	18.7	3.6	18.6	4.0	18.5	4.3	18.4	4.6
20	19.8	2.8	19.8	3.1	19.7	3.5	19.6	3.8	19.6	4.2	19.5	4.5	19.4	4.8
21	20.8	2.9	20.7	3.3	20.7	3.6	20.6	4.0	20.5	4.4	20.5	4.7	20.4	5.1
22	21.8	3.1	21.7	3.4	21.7	3.8	21.6	4.2	21.5	4.6	21.4	4.9	21.3	5.3
23	22.8	3.2	22.7	3.6	22.7	4.0	22.6	4.4	22.5	4.8	22.4	5.2	22.3	5.6
24	23.8	3.3	23.7	3.8	23.6	4.2	23.6	4.6	23.5	5.0	23.4	5.4	23.3	5.8
25	24.8	3.5	24.7	3.9	24.6	4.3	24.5	4.8	24.5	5.2	24.4	5.6	24.3	6.0
26	25.7	3.6	25.7	4.1	25.6	4.5	25.5	5.0	25.4	5.4	25.3	5.8	25.2	6.3
27	26.7	3.8	26.7	4.2	26.6	4.7	26.5	5.2	26.4	5.6	26.3	6.1	26.2	6.5
28	27.7	3.9	27.7	4.4	27.6	4.9	27.5	5.3	27.4	5.8	27.3	6.3	27.2	6.8
29	28.7	4.0	28.6	4.5	28.6	5.0	28.5	5.5	28.4	6.0	28.3	6.5	28.1	7.0
30	29.7	4.2	29.6	4.7	29.5	5.2	29.4	5.7	29.3	6.2	29.2	6.7	29.1	7.3
31	30.7	4.3	30.6	4.8	30.5	5.4	30.4	5.9	30.3	6.4	30.2	7.0	30.1	7.5
32	31.7	4.5	31.6	5.0	31.5	5.6	31.4	6.1	31.3	6.7	31.2	7.2	31.0	7.7
33	32.7	4.6	32.6	5.2	32.5	5.7	32.4	6.3	32.3	6.9	32.2	7.4	32.0	8.0
34	33.7	4.7	33.6	5.3	33.5	5.9	33.4	6.5	33.3	7.1	33.1	7.6	33.0	8.2
35	34.7	4.9	34.6	5.5	34.5	6.1	34.4	6.7	34.2	7.3	34.1	7.9	34.0	8.5
36	35.6	5.0	35.6	5.6	35.5	6.3	35.3	6.9	35.2	7.5	35.1	8.1	34.9	8.7
37	36.6	5.1	36.5	5.8	36.4	6.4	36.3	7.1	36.2	7.7	36.1	8.3	35.9	9.0
38	37.6	5.3	37.5	5.9	37.4	6.6	37.3	7.3	37.2	7.9	37.0	8.5	36.9	9.2
39	38.6	5.4	38.5	6.1	38.4	6.8	38.3	7.4	38.1	8.1	38.0	8.8	37.8	9.4
40	39.6	5.6	39.5	6.3	39.4	6.9	39.3	7.6	39.1	8.3	39.0	9.0	38.8	9.7
41	40.6	5.7	40.5	6.4	40.4	7.1	40.2	7.8	40.1	8.5	39.9	9.2	39.8	9.9
42	41.6	5.8	41.5	6.6	41.4	7.3	41.2	8.0	41.1	8.7	40.9	9.4	40.8	10.2
43	42.6	6.0	42.5	6.7	42.3	7.5	42.2	8.2	42.1	8.9	41.9	9.7	41.7	10.4
44	43.6	6.1	43.5	6.9	43.3	7.6	43.2	8.4	43.0	9.1	42.9	9.9	42.7	10.6
45	44.6	6.3	44.4	7.0	44.3	7.8	44.2	8.6	44.0	9.4	43.8	10.1	43.7	10.9
46	45.6	6.4	45.4	7.2	45.3	8.0	45.2	8.8	45.0	9.6	44.8	10.3	44.6	11.1
47	46.5	6.5	46.4	7.4	46.3	8.2	46.1	9.0	46.0	9.8	45.8	10.6	45.6	11.4
48	47.5	6.7	47.4	7.5	47.3	8.3	47.1	9.2	47.0	10.0	46.8	10.8	46.6	11.6
49	48.5	6.8	48.4	7.7	48.3	8.5	48.1	9.3	47.9	10.2	47.7	11.0	47.5	11.9
50	49.5	7.0	49.4	7.8	49.2	8.7	49.1	9.5	48.9	10.4	48.7	11.2	48.5	12.1
100	99.0	13.9	98.8	15.6	98.5	17.4	98.2	19.1	97.8	20.8	97.4	22.5	97.0	24.2
200	198.1	27.8	197.5	31.3	197.0	34.7	196.3	38.2	195.6	41.6	194.9	45.0	194.1	48.4
300	297.1	41.8	296.3	46.9	295.4	52.1	294.5	57.2	293.4	62.4	292.3	67.5	291.1	72.6
400	396.1	55.7	395.1	62.6	393.9	69.5	392.6	76.3	391.3	83.1	389.8	90.0	388.1	96.7
500	495.1	69.6	493.8	78.2	492.4	86.8	490.8	95.4	489.1	104.0	487.2	112.4	485.1	121.0
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(98°, 262°, 278°) 7¼ Pt. **82°**		(99°, 261°, 279°) **81°**		(100°, 260°, 280°) **80°**		(101°, 259°, 281°) 7 Pt. **79°**		(102°, 258°, 282°) **78°**		(103°, 257°, 283°) **77°**		(104°, 256°, 284°) 6¾ Pt. **76°**	

The 1-Pt. or 11° Courses are: N. by E., N. by W., S. by E., S. by W.

Dist.	¾ Pt. **8°** (172°, 188°, 352°)		**9°** (171°, 189°, 351°)		**10°** (170°, 190°, 350°)		1 Pt. **11°** (169°, 191°, 349°)		**12°** (168°, 192°, 348°)		**13°** (167°, 193°, 347°)		1¼ Pt. **14°** (166°, 194°, 346°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	50.5	7.1	50.4	8.0	50.2	8.9	50.1	9.7	49.9	10.6	49.7	11.5	49.5	12.3
52	51.5	7.2	51.4	8.1	51.2	9.0	51.0	9.9	50.9	10.8	50.7	11.7	50.5	12.6
53	52.5	7.4	52.3	8.3	52.2	9.2	52.0	10.1	51.8	11.0	51.6	11.9	51.4	12.8
54	53.5	7.5	53.3	8.4	53.2	9.4	53.0	10.3	52.8	11.2	52.6	12.1	52.4	13.1
55	54.5	7.7	54.3	8.6	54.2	9.6	54.0	10.5	53.8	11.4	53.6	12.4	53.4	13.3
56	55.5	7.8	55.3	8.8	55.1	9.7	55.0	10.7	54.8	11.6	54.6	12.6	54.3	13.5
57	56.4	7.9	56.3	8.9	56.1	9.9	56.0	10.9	55.8	11.9	55.5	12.8	55.3	13.8
58	57.4	8.1	57.3	9.1	57.1	10.1	56.9	11.1	56.7	12.1	56.5	13.0	56.3	14.0
59	58.4	8.2	58.3	9.2	58.1	10.2	57.9	11.3	57.7	12.3	57.5	13.3	57.2	14.3
60	59.4	8.4	59.3	9.4	59.1	10.4	58.9	11.4	58.7	12.5	58.5	13.5	58.2	14.5
61	60.4	8.5	60.2	9.5	60.1	10.6	59.9	11.6	59.7	12.7	59.4	13.7	59.2	14.8
62	61.4	8.6	61.2	9.7	61.1	10.8	60.9	11.8	60.6	12.9	60.4	13.9	60.2	15.0
63	62.4	8.8	62.2	9.9	62.0	10.9	61.8	12.0	61.6	13.1	61.4	14.2	61.1	15.2
64	63.4	8.9	63.2	10.0	63.0	11.1	62.8	12.2	62.6	13.3	62.4	14.4	62.1	15.5
65	64.4	9.0	64.2	10.2	64.0	11.3	63.8	12.4	63.6	13.5	63.3	14.6	63.1	15.7
66	65.4	9.2	65.2	10.3	65.0	11.5	64.8	12.6	64.6	13.7	64.3	14.8	64.0	16.0
67	66.3	9.3	66.2	10.5	66.0	11.6	65.8	12.8	65.5	13.9	65.3	15.1	65.0	16.2
68	67.3	9.5	67.2	10.6	67.0	11.8	66.8	13.0	66.5	14.1	66.3	15.3	66.0	16.5
69	68.3	9.6	68.2	10.8	68.0	12.0	67.7	13.2	67.5	14.3	67.2	15.5	67.0	16.7
70	69.3	9.7	69.1	11.0	68.9	12.2	68.7	13.4	68.5	14.6	68.2	15.7	67.9	16.9
71	70.3	9.9	70.1	11.1	69.9	12.3	69.7	13.5	69.4	14.8	69.2	16.0	68.9	17.2
72	71.3	10.0	71.1	11.3	70.9	12.5	70.7	13.7	70.4	15.0	70.2	16.2	69.9	17.4
73	72.3	10.2	72.1	11.4	71.9	12.7	71.7	13.9	71.4	15.2	71.1	16.4	70.8	17.7
74	73.3	10.3	73.1	11.6	72.9	12.8	72.6	14.1	72.4	15.4	72.1	16.6	71.8	17.9
75	74.3	10.4	74.1	11.7	73.9	13.0	73.6	14.3	73.4	15.6	73.1	16.9	72.8	18.1
76	75.3	10.6	75.1	11.9	74.8	13.2	74.6	14.5	74.3	15.8	74.1	17.1	73.7	18.4
77	76.3	10.7	76.1	12.0	75.8	13.4	75.6	14.7	75.3	16.0	75.0	17.3	74.7	18.6
78	77.2	10.9	77.0	12.2	76.8	13.5	76.6	14.9	76.3	16.2	76.0	17.5	75.7	18.9
79	78.2	11.0	78.0	12.4	77.8	13.7	77.5	15.1	77.3	16.4	77.0	17.8	76.7	19.1
80	79.2	11.1	79.0	12.5	78.8	13.9	78.5	15.3	78.3	16.6	77.9	18.0	77.6	19.4
81	80.2	11.3	80.0	12.7	79.8	14.1	79.5	15.5	79.2	16.8	78.9	18.2	78.6	19.6
82	81.2	11.4	81.0	12.8	80.8	14.2	80.5	15.6	80.2	17.0	79.9	18.4	79.6	19.8
83	82.2	11.6	82.0	13.0	81.7	14.4	81.5	15.8	81.2	17.3	80.9	18.7	80.5	20.1
84	83.2	11.7	83.0	13.1	82.7	14.6	82.5	16.0	82.2	17.5	81.8	18.9	81.5	20.3
85	84.2	11.8	84.0	13.3	83.7	14.8	83.4	16.2	83.1	17.7	82.8	19.1	82.5	20.6
86	85.2	12.0	84.9	13.5	84.7	14.9	84.4	16.4	84.1	17.9	83.8	19.3	83.4	20.8
87	86.2	12.1	85.9	13.6	85.7	15.1	85.4	16.6	85.1	18.1	84.8	19.6	84.4	21.0
88	87.1	12.2	86.9	13.8	86.7	15.3	86.4	16.8	86.1	18.3	85.7	19.8	85.4	21.3
89	88.1	12.4	87.9	13.9	87.6	15.5	87.4	17.0	87.1	18.5	86.7	20.0	86.4	21.5
90	89.1	12.5	88.9	14.1	88.6	15.6	88.3	17.2	88.0	18.7	87.7	20.2	87.3	21.8
91	90.1	12.7	89.9	14.2	89.6	15.8	89.3	17.4	89.0	18.9	88.7	20.5	88.3	22.0
92	91.1	12.8	90.9	14.4	90.6	16.0	90.3	17.6	90.0	19.1	89.6	20.7	89.3	22.3
93	92.1	12.9	91.9	14.5	91.6	16.1	91.3	17.7	91.0	19.3	90.6	20.9	90.2	22.5
94	93.1	13.1	92.8	14.7	92.6	16.3	92.3	17.9	91.9	19.5	91.6	21.1	91.2	22.7
95	94.1	13.2	93.8	14.9	93.6	16.5	93.3	18.1	92.9	19.8	92.6	21.4	92.2	23.0
96	95.1	13.4	94.8	15.0	94.5	16.7	94.2	18.3	93.9	20.0	93.5	21.6	93.1	23.2
97	96.1	13.5	95.8	15.2	95.5	16.8	95.2	18.5	94.9	20.2	94.5	21.8	94.1	23.5
98	97.0	13.6	96.8	15.3	96.5	17.0	96.2	18.7	95.9	20.4	95.5	22.0	95.1	23.7
99	98.0	13.8	97.8	15.5	97.5	17.2	97.2	18.9	96.8	20.6	96.5	22.3	96.1	24.0
100	99.0	13.9	98.8	15.6	98.5	17.4	98.2	19.1	97.8	20.8	97.4	22.5	97.0	24.2
600	594.2	83.5	592.6	93.8	590.9	104.2	589.0	114.5	586.9	124.7	584.6	135.0	582.2	145.1
700	693.3	97.4	691.3	109.4	689.5	121.5	687.1	133.6	684.7	145.5	682.1	157.5	679.2	169.3
800	792.3	111.4	790.2	125.1	787.9	139.0	785.2	152.6	782.5	166.3	779.4	180.0	776.2	193.6
900	891.3	125.2	888.8	140.8	886.3	156.3	883.3	171.7	880.2	187.1	876.8	202.4	873.2	217.7
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(98°, 262°, 278°) 7¾ Pt. **82°**		(99°, 261°, 279°) **81°**		(100°, 260°, 280°) **80°**		(101°, 259°, 281°) 7 Pt. **79°**		(102°, 258°, 282°) **78°**		(103°, 257°, 283°) **77°**		(104°, 256°, 284°) 6¾ Pt. **76°**	

The 7-Pt. or 79° Courses are: E. by N., W. by N., E. by S., W. by S.

Dist.	15° (165°, 195°, 345°)		16° (164°, 196°, 344°)		1½ Pt. 17° (163°, 197°, 343°)		18° (162°, 198°, 342°)		19° (161°, 199°, 341°)		1¾ Pt. 20° (160°, 200°, 340°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	0.9	0.3	0.9	0.3
2	1.9	0.5	1.9	0.6	1.9	0.6	1.9	0.6	1.9	0.7	1.9	0.7
3	2.9	0.8	2.9	0.8	2.9	0.9	2.9	0.9	2.8	1.0	2.8	1.0
4	3.9	1.0	3.8	1.1	3.8	1.2	3.8	1.2	3.8	1.3	3.8	1.4
5	4.8	1.3	4.8	1.4	4.8	1.5	4.8	1.5	4.7	1.6	4.7	1.7
6	5.8	1.6	5.8	1.7	5.7	1.8	5.7	1.9	5.7	2.0	5.6	2.1
7	6.8	1.8	6.7	1.9	6.7	2.0	6.7	2.2	6.6	2.3	6.6	2.4
8	7.7	2.1	7.7	2.2	7.7	2.3	7.6	2.5	7.6	2.6	7.5	2.7
9	8.7	2.3	8.7	2.5	8.6	2.6	8.6	2.8	8.5	2.9	8.5	3.1
10	9.7	2.6	9.6	2.8	9.6	2.9	9.5	3.1	9.5	3.3	9.4	3.4
11	10.6	2.8	10.6	3.0	10.5	3.2	10.5	3.4	10.4	3.6	10.3	3.8
12	11.6	3.1	11.5	3.3	11.5	3.5	11.4	3.7	11.3	3.9	11.3	4.1
13	12.6	3.4	12.5	3.6	12.4	3.8	12.4	4.0	12.3	4.2	12.2	4.4
14	13.5	3.6	13.5	3.9	13.4	4.1	13.3	4.3	13.2	4.6	13.2	4.8
15	14.5	3.9	14.4	4.1	14.3	4.4	14.3	4.6	14.2	4.9	14.1	5.1
16	15.5	4.1	15.4	4.4	15.3	4.7	15.2	4.9	15.1	5.2	15.0	5.5
17	16.4	4.4	16.3	4.7	16.3	5.0	16.2	5.3	16.1	5.5	16.0	5.8
18	17.4	4.7	17.3	5.0	17.2	5.3	17.1	5.6	17.0	5.9	16.9	6.2
19	18.4	4.9	18.3	5.2	18.2	5.6	18.1	5.9	18.0	6.2	17.9	6.5
20	19.3	5.2	19.2	5.5	19.1	5.8	19.0	6.2	18.9	6.5	18.8	6.8
21	20.3	5.4	20.2	5.8	20.1	6.1	20.0	6.5	19.9	6.8	19.7	7.2
22	21.3	5.7	21.1	6.1	21.0	6.4	20.9	6.8	20.8	7.2	20.7	7.5
23	22.2	6.0	22.1	6.3	22.0	6.7	21.9	7.1	21.7	7.5	21.6	7.9
24	23.2	6.2	23.1	6.6	23.0	7.0	22.8	7.4	22.7	7.8	22.6	8.2
25	24.1	6.5	24.0	6.9	23.9	7.3	23.8	7.7	23.6	8.1	23.5	8.6
26	25.1	6.7	25.0	7.2	24.9	7.6	24.7	8.0	24.6	8.5	24.4	8.9
27	26.1	7.0	26.0	7.4	25.8	7.9	25.7	8.3	25.5	8.8	25.4	9.2
28	27.0	7.2	26.9	7.7	26.8	8.2	26.6	8.7	26.5	9.1	26.3	9.6
29	28.0	7.5	27.9	8.0	27.7	8.5	27.6	9.0	27.4	9.4	27.3	9.9
30	29.0	7.8	28.8	8.3	28.7	8.8	28.5	9.3	28.4	9.8	28.2	10.3
31	29.9	8.0	29.8	8.5	29.6	9.1	29.5	9.6	29.3	10.1	29.1	10.6
32	30.9	8.3	30.8	8.8	30.6	9.4	30.4	9.9	30.3	10.4	30.1	10.9
33	31.9	8.5	31.7	9.1	31.6	9.6	31.4	10.2	31.2	10.7	31.0	11.3
34	32.8	8.8	32.7	9.4	32.5	9.9	32.3	10.5	32.1	11.1	31.9	11.6
35	33.8	9.1	33.6	9.6	33.5	10.2	33.3	10.8	33.1	11.4	32.9	12.0
36	34.8	9.3	34.6	9.9	34.4	10.5	34.2	11.1	34.0	11.7	33.8	12.3
37	35.7	9.6	35.6	10.2	35.4	10.8	35.2	11.4	35.0	12.0	34.8	12.7
38	36.7	9.8	36.5	10.5	36.3	11.1	36.1	11.7	35.9	12.4	35.7	13.0
39	37.7	10.1	37.5	10.7	37.3	11.4	37.1	12.1	36.9	12.7	36.6	13.3
40	38.6	10.4	38.5	11.0	38.3	11.7	38.0	12.4	37.8	13.0	37.6	13.7
41	39.6	10.6	39.4	11.3	39.2	12.0	39.0	12.7	38.8	13.3	38.5	14.0
42	40.6	10.9	40.4	11.6	40.2	12.3	39.9	13.0	39.7	13.7	39.5	14.4
43	41.5	11.1	41.3	11.9	41.1	12.6	40.9	13.3	40.7	14.0	40.4	14.7
44	42.5	11.4	42.3	12.1	42.1	12.9	41.8	13.6	41.6	14.3	41.3	15.0
45	43.5	11.6	43.3	12.4	43.0	13.2	42.8	13.9	42.5	14.7	42.3	15.4
46	44.4	11.9	44.2	12.7	44.0	13.4	43.7	14.2	43.5	15.0	43.2	15.7
47	45.4	12.2	45.2	13.0	44.9	13.7	44.7	14.5	44.4	15.3	44.2	16.1
48	46.4	12.4	46.1	13.2	45.9	14.0	45.7	14.8	45.4	15.6	45.1	16.4
49	47.3	12.7	47.1	13.5	46.9	14.3	46.6	15.1	46.3	16.0	46.0	16.8
50	48.3	12.9	48.1	13.8	47.8	14.6	47.6	15.5	47.3	16.3	47.0	17.1
100	96.6	25.9	96.1	27.6	95.6	29.2	95.1	30.9	94.6	32.6	94.0	34.2
200	193.2	51.8	192.3	55.1	191.3	58.5	190.2	61.8	189.1	65.1	187.9	68.4
300	289.8	77.6	288.4	82.7	286.9	87.7	285.3	92.7	283.7	97.7	281.9	102.6
400	386.3	103.5	384.5	110.2	382.5	117.0	380.4	123.6	378.2	130.2	375.9	136.8
500	483.0	129.4	480.6	137.8	478.1	146.2	475.5	154.5	472.8	162.8	469.9	171.0
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(105°, 255°, 285°) 75°		(106°, 254°, 286°) 74°		(107°, 253°, 287°) 6½ Pt. 73°		(108°, 252°, 288°) 72°		(109°, 251°, 289°) 71°		(110°, 250°, 290°) 6¼ Pt. 70°	

Dist.	15° (165°, 195°, 345°)		16° (164°, 196°, 344°)		1½ Pt. 17° (163°, 197°, 343°)		18° (162°, 198°, 342°)		19° (161°, 199°, 341°)		1¾ Pt. 20° (160°, 200°, 340°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	49.3	13.2	49.0	14.1	48.8	14.9	48.5	15.8	48.2	16.6	47.9	17.4
52	50.2	13.5	50.0	14.3	49.7	15.2	49.5	16.1	49.2	16.9	48.9	17.8
53	51.2	13.7	50.9	14.6	50.7	15.5	50.4	16.4	50.1	17.3	49.8	18.1
54	52.2	14.0	51.9	14.9	51.6	15.8	51.4	16.7	51.1	17.6	50.7	18.5
55	53.1	14.2	52.9	15.2	52.6	16.1	52.3	17.0	52.0	17.9	51.7	18.8
56	54.1	14.5	53.8	15.4	53.6	16.4	53.3	17.3	52.9	18.2	52.6	19.2
57	55.1	14.8	54.8	15.7	54.5	16.7	54.2	17.6	53.9	18.6	53.6	19.5
58	56.0	15.0	55.8	16.0	55.5	17.0	55.2	17.9	54.8	18.9	54.5	19.8
59	57.0	15.3	56.7	16.3	56.4	17.2	56.1	18.2	55.8	19.2	55.4	20.2
60	58.0	15.5	57.7	16.5	57.4	17.5	57.1	18.5	56.7	19.5	56.4	20.5
61	58.9	15.8	58.6	16.8	58.3	17.8	58.0	18.9	57.7	19.9	57.3	20.9
62	59.9	16.0	59.6	17.1	59.3	18.1	59.0	19.2	58.6	20.2	58.3	21.2
63	60.9	16.3	60.6	17.4	60.2	18.4	59.9	19.5	59.6	20.5	59.2	21.5
64	61.8	16.6	61.5	17.6	61.2	18.7	60.9	19.8	60.5	20.8	60.1	21.9
65	62.8	16.8	62.5	17.9	62.2	19.0	61.8	20.1	61.5	21.2	61.1	22.2
66	63.8	17.1	63.4	18.2	63.1	19.3	62.8	20.4	62.4	21.5	62.0	22.6
67	64.7	17.3	64.4	18.5	64.1	19.6	63.7	20.7	63.3	21.8	63.0	22.9
68	65.7	17.6	65.4	18.7	65.0	19.9	64.7	21.0	64.3	22.1	63.9	23.3
69	66.6	17.9	66.3	19.0	66.0	20.2	65.6	21.3	65.2	22.5	64.8	23.6
70	67.6	18.1	67.3	19.3	66.9	20.5	66.6	21.6	66.2	22.8	65.8	23.9
71	68.6	18.4	68.2	19.6	67.9	20.8	67.5	21.9	67.1	23.1	66.7	24.3
72	69.5	18.6	69.2	19.8	68.9	21.1	68.5	22.2	68.1	23.4	67.7	24.6
73	70.5	18.9	70.2	20.1	69.8	21.3	69.4	22.6	69.0	23.8	68.6	25.0
74	71.5	19.2	71.1	20.4	70.8	21.6	70.4	22.9	70.0	24.1	69.5	25.3
75	72.4	19.4	72.1	20.7	71.7	21.9	71.3	23.2	70.9	24.4	70.5	25.7
76	73.4	19.7	73.1	20.9	72.7	22.2	72.3	23.5	71.9	24.7	71.4	26.0
77	74.4	19.9	74.0	21.2	73.6	22.5	73.2	23.8	72.8	25.1	72.4	26.3
78	75.3	20.2	75.0	21.5	74.6	22.8	74.2	24.1	73.8	25.4	73.3	26.7
79	76.3	20.4	75.9	21.8	75.5	23.1	75.1	24.4	74.7	25.7	74.2	27.0
80	77.3	20.7	76.9	22.1	76.5	23.4	76.1	24.7	75.6	26.0	75.2	27.4
81	78.2	21.0	77.9	22.3	77.5	23.7	77.0	25.0	76.6	26.4	76.1	27.7
82	79.2	21.2	78.8	22.6	78.4	24.0	78.0	25.3	77.5	26.7	77.1	28.0
83	80.2	21.5	79.8	22.9	79.4	24.3	78.9	25.6	78.5	27.0	78.0	28.4
84	81.1	21.7	80.7	23.2	80.3	24.6	79.9	26.0	79.4	27.3	78.9	28.7
85	82.1	22.0	81.7	23.4	81.3	24.9	80.8	26.3	80.4	27.7	79.9	29.1
86	83.1	22.3	82.7	23.7	82.2	25.1	81.8	26.6	81.3	28.0	80.8	29.4
87	84.0	22.5	83.6	24.0	83.2	25.4	82.7	26.9	82.3	28.3	81.8	29.8
88	85.0	22.8	84.6	24.3	84.2	25.7	83.7	27.2	83.2	28.7	82.7	30.1
89	86.0	23.0	85.6	24.5	85.1	26.0	84.6	27.5	84.2	29.0	83.6	30.4
90	86.9	23.3	86.5	24.8	86.1	26.3	85.6	27.8	85.1	29.3	84.6	30.8
91	87.9	23.6	87.5	25.1	87.0	26.6	86.5	28.1	86.0	29.6	85.5	31.1
92	88.9	23.8	88.4	25.4	88.0	26.9	87.5	28.4	87.0	30.0	86.5	31.5
93	89.8	24.1	89.4	25.6	88.9	27.2	88.4	28.7	87.9	30.3	87.4	31.8
94	90.8	24.3	90.4	25.9	89.9	27.5	89.4	29.0	88.9	30.6	88.3	32.1
95	91.8	24.6	91.3	26.2	90.8	27.8	90.4	29.4	89.8	30.9	89.3	32.5
96	92.7	24.8	92.3	26.5	91.8	28.1	91.3	29.7	90.8	31.3	90.2	32.8
97	93.7	25.1	93.2	26.7	92.8	28.4	92.3	30.0	91.7	31.6	91.2	33.2
98	94.7	25.4	94.2	27.0	93.7	28.7	93.2	30.3	92.7	31.9	92.1	33.5
99	95.6	25.6	95.2	27.3	94.7	28.9	94.2	30.6	93.6	32.2	93.0	33.9
100	96.6	25.9	96.1	27.6	95.6	29.2	95.1	30.9	94.6	32.6	94.0	34.2
600	579.5	155.3	576.8	165.4	573.8	175.4	570.6	185.4	567.3	195.3	563.8	205.2
700	676.1	181.1	672.8	193.0	669.4	204.6	665.8	216.3	661.9	227.9	657.9	239.4
800	772.7	207.0	769.0	220.5	765.0	233.9	760.8	247.3	756.5	260.4	751.8	273.6
900	869.2	232.9	865.0	248.0	860.6	263.1	855.9	278.1	850.9	292.9	845.7	307.8
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(105°, 255°, 285°) 75°		(106°, 254°, 286°) 74°		(107°, 253°, 287°) 6½ Pt. 73°		(108°, 252°, 288°) 72°		(109°, 251°, 289°) 71°		(110°, 250°, 290°) 70°	

Dist.	21° (159°, 201°, 339°)		22° (158°, 202°, 338°)		2 Pt. 23° (157°, 203°, 337°)		24° (156°, 204°, 336°)		$2\frac{1}{4}$ Pt. 25° (155°, 205°, 335°)		26° (154°, 206°, 334°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	0.9	0.4	0.9	0.4	0.9	0.4	0.9	0.4	0.9	0.4	0.9	0.4
2	1.9	0.7	1.9	0.7	1.8	0.8	1.8	0.8	1.8	0.8	1.8	0.9
3	2.8	1.1	2.8	1.1	2.8	1.2	2.7	1.2	2.7	1.3	2.7	1.3
4	3.7	1.4	3.7	1.5	3.7	1.6	3.7	1.6	3.6	1.7	3.6	1.8
5	4.7	1.8	4.6	1.9	4.6	2.0	4.6	2.0	4.5	2.1	4.5	2.2
6	5.6	2.2	5.6	2.2	5.5	2.3	5.5	2.4	5.4	2.5	5.4	2.6
7	6.5	2.5	6.5	2.6	6.4	2.7	6.4	2.8	6.3	3.0	6.3	3.1
8	7.5	2.9	7.4	3.0	7.4	3.1	7.3	3.3	7.3	3.4	7.2	3.5
9	8.4	3.2	8.3	3.4	8.3	3.5	8.2	3.7	8.2	3.8	8.1	3.9
10	9.3	3.6	9.3	3.7	9.2	3.9	9.1	4.1	9.1	4.2	9.0	4.4
11	10.3	3.9	10.2	4.1	10.1	4.3	10.0	4.5	10.0	4.6	9.9	4.8
12	11.2	4.3	11.1	4.5	11.0	4.7	11.0	4.9	10.9	5.1	10.8	5.3
13	12.1	4.7	12.1	4.9	12.0	5.1	11.9	5.3	11.8	5.5	11.7	5.7
14	13.1	5.0	13.0	5.2	12.9	5.5	12.8	5.7	12.7	5.9	12.6	6.1
15	14.0	5.4	13.9	5.6	13.8	5.9	13.7	6.1	13.6	6.3	13.5	6.6
16	14.9	5.7	14.8	6.0	14.7	6.3	14.6	6.5	14.5	6.8	14.4	7.0
17	15.9	6.1	15.8	6.4	15.6	6.6	15.5	6.9	15.4	7.2	15.3	7.5
18	16.8	6.5	16.7	6.7	16.6	7.0	16.4	7.3	16.3	7.6	16.2	7.9
19	17.7	6.8	17.6	7.1	17.5	7.4	17.4	7.7	17.2	8.0	17.1	8.3
20	18.7	7.2	18.5	7.5	18.4	7.8	18.3	8.1	18.1	8.5	18.0	8.8
21	19.6	7.5	19.5	7.9	19.3	8.2	19.2	8.5	19.0	8.9	18.9	9.2
22	20.5	7.9	20.4	8.2	20.3	8.6	20.1	8.9	19.9	9.3	19.8	9.6
23	21.5	8.2	21.3	8.6	21.2	9.0	21.0	9.4	20.8	9.7	20.7	10.1
24	22.4	8.6	22.3	9.0	22.1	9.4	21.9	9.8	21.8	10.1	21.6	10.5
25	23.3	9.0	23.2	9.4	23.0	9.8	22.8	10.2	22.7	10.6	22.5	11.0
26	24.3	9.3	24.1	9.7	23.9	10.2	23.8	10.6	23.6	11.0	23.4	11.4
27	25.2	9.7	25.0	10.1	24.9	10.5	24.7	11.0	24.5	11.4	24.3	11.8
28	26.1	10.0	26.0	10.5	25.8	10.9	25.6	11.4	25.4	11.8	25.2	12.3
29	27.1	10.4	26.9	10.9	26.7	11.3	26.5	11.8	26.3	12.3	26.1	12.7
30	28.0	10.8	27.8	11.2	27.6	11.7	27.4	12.2	27.2	12.7	27.0	13.2
31	28.9	11.1	28.7	11.6	28.5	12.1	28.3	12.6	28.1	13.1	27.9	13.6
32	29.9	11.5	29.7	12.0	29.5	12.5	29.2	13.0	29.0	13.5	28.8	14.0
33	30.8	11.8	30.6	12.4	30.4	12.9	30.1	13.4	29.9	13.9	29.7	14.5
34	31.7	12.2	31.5	12.7	31.3	13.3	31.1	13.8	30.8	14.4	30.6	14.9
35	32.7	12.5	32.5	13.1	32.2	13.7	32.0	14.2	31.7	14.8	31.5	15.3
36	33.6	12.9	33.4	13.5	33.1	14.1	32.9	14.6	32.6	15.2	32.4	15.8
37	34.5	13.3	34.3	13.9	34.1	14.5	33.8	15.0	33.5	15.6	33.3	16.2
38	35.5	13.6	35.2	14.2	35.0	14.8	34.7	15.5	34.4	16.1	34.2	16.7
39	36.4	14.0	36.2	14.6	35.9	15.2	35.6	15.9	35.3	16.5	35.1	17.1
40	37.3	14.3	37.1	15.0	36.8	15.6	36.5	16.3	36.3	16.9	36.0	17.5
41	38.3	14.7	38.0	15.4	37.7	16.0	37.5	16.7	37.2	17.3	36.9	18.0
42	39.2	15.1	38.9	15.7	38.7	16.4	38.4	17.1	38.1	17.7	37.7	18.4
43	40.1	15.4	39.9	16.1	39.6	16.8	39.3	17.5	39.0	18.2	38.6	18.8
44	41.1	15.8	40.8	16.5	40.5	17.2	40.2	17.9	39.9	18.6	39.5	19.3
45	42.0	16.1	41.7	16.9	41.4	17.6	41.1	18.3	40.8	19.0	40.4	19.7
46	42.9	16.5	42.7	17.2	42.3	18.0	42.0	18.7	41.7	19.4	41.3	20.2
47	43.9	16.8	43.6	17.6	43.3	18.4	42.9	19.1	42.6	19.9	42.2	20.6
48	44.8	17.2	44.5	18.0	44.2	18.8	43.9	19.5	43.5	20.3	43.1	21.0
49	45.7	17.6	45.4	18.4	45.1	19.1	44.8	19.9	44.4	20.7	44.0	21.5
50	46.7	17.9	46.4	18.7	46.0	19.5	45.7	20.3	45.3	21.1	44.9	21.9
100	93.4	35.8	92.7	37.5	92.1	39.1	91.4	40.7	90.6	42.3	89.9	43.8
200	186.7	71.7	185.4	74.9	184.1	78.1	182.7	81.3	181.3	84.5	179.8	87.7
300	280.1	107.5	278.2	112.4	276.2	117.2	274.1	122.0	271.9	126.8	269.6	131.5
400	373.4	143.4	370.9	149.8	368.2	156.3	365.4	162.7	362.5	169.0	359.5	175.4
500	466.8	179.2	463.6	187.3	460.2	195.4	456.8	203.4	453.1	211.3	449.4	219.2
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(111°, 249°, 291°) 69°		(112°, 248,° 292°) 6 Pt. 68°		(113°, 247°, 293°) 67°		(114°, 246°, 294°) 66°		(115°, 245°, 295°) $5\frac{3}{4}$ Pt. 65°		(116°, 244°, 296°) 64°	

The 2-Pt. or 23° Courses are: N.N.E., N.N.W., S.S.E., S.S.W.

Dist.	21° (159°, 201°, 339°)		22° (158°, 202°, 338°)		2 Pt. 23° (157°, 203°, 337°)		24° (156°, 204°, 336°)		2¼ Pt. 25° (155°, 205°, 335°)		26° (154°, 206°, 334°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	47.6	18.3	47.3	19.1	46.9	19.9	46.6	20.7	46.2	21.6	45.8	22.4
52	48.5	18.6	48.2	19.5	47.9	20.3	47.5	21.2	47.1	22.0	46.7	22.8
53	49.5	19.0	49.1	19.9	48.8	20.7	48.4	21.6	48.0	22.4	47.6	23.2
54	50.4	19.4	50.1	20.2	49.7	21.1	49.3	22.0	48.9	22.8	48.5	23.7
55	51.3	19.7	51.0	20.6	50.6	21.5	50.2	22.4	49.8	23.2	49.4	24.1
56	52.3	20.1	51.9	21.0	51.5	21.9	51.2	22.8	50.8	23.7	50.3	24.5
57	53.2	20.4	52.8	21.4	52.5	22.3	52.1	23.2	51.7	24.1	51.2	25.0
58	54.1	20.8	53.8	21.7	53.4	22.7	53.0	23.6	52.6	24.5	52.1	25.4
59	55.1	21.1	54.7	22.1	54.3	23.1	53.9	24.0	53.5	24.9	53.0	25.9
60	56.0	21.5	55.6	22.5	55.2	23.4	54.8	24.4	54.4	25.4	53.9	26.3
61	56.9	21.9	56.6	22.9	56.2	23.8	55.7	24.8	55.3	25.8	54.8	26.7
62	57.9	22.2	57.5	23.2	57.1	24.2	56.6	25.2	56.2	26.2	55.7	27.2
63	58.8	22.6	58.4	23.6	58.0	24.6	57.6	25.6	57.1	26.6	56.6	27.6
64	59.7	22.9	59.3	24.0	58.9	25.0	58.5	26.0	58.0	27.0	57.5	28.1
65	60.7	23.3	60.3	24.3	59.8	25.4	59.4	26.4	58.9	27.5	58.4	28.5
66	61.6	23.7	61.2	24.7	60.8	25.8	60.3	26.8	59.8	27.9	59.3	28.9
67	62.5	24.0	62.1	25.1	61.7	26.2	61.2	27.3	60.7	28.3	60.2	29.4
68	63.5	24.4	63.0	25.5	62.6	26.6	62.1	27.7	61.6	28.7	61.1	29.8
69	64.4	24.7	64.0	25.8	63.5	27.0	63.0	28.1	62.5	29.2	62.0	30.2
70	65.4	25.1	64.9	26.2	64.4	27.4	63.9	28.5	63.4	29.6	62.9	30.7
71	66.3	25.4	65.8	26.6	65.4	27.7	64.9	28.9	64.3	30.0	63.8	31.1
72	67.2	25.8	66.8	27.0	66.3	28.1	65.8	29.3	65.3	30.4	64.7	31.6
73	68.2	26.2	67.7	27.3	67.2	28.5	66.7	29.7	66.2	30.9	65.6	32.0
74	69.1	26.5	68.6	27.7	68.1	28.9	67.6	30.1	67.1	31.3	66.5	32.4
75	70.0	26.9	69.5	28.1	69.0	29.3	68.5	30.5	68.0	31.7	67.4	32.9
76	71.0	27.2	70.5	28.5	70.0	29.7	69.4	30.9	68.9	32.1	68.3	33.3
77	71.9	27.6	71.4	28.8	70.9	30.1	70.3	31.3	69.8	32.5	69.2	33.8
78	72.8	28.0	72.3	29.2	71.8	30.5	71.3	31.7	70.7	33.0	70.1	34.2
79	73.0	28.3	73.2	29.6	72.7	30.9	72.2	32.1	71.6	33.4	71.0	34.6
80	74.7	28.7	74.2	30.0	73.6	31.3	73.1	32.5	72.5	33.8	71.9	35.1
81	75.6	29.0	75.1	30.3	74.6	31.6	74.0	32.9	73.4	34.2	72.8	35.5
82	76.6	29.4	76.0	30.7	75.5	32.0	74.9	33.4	74.3	34.7	73.7	35.9
83	77.5	29.7	77.0	31.1	76.4	32.4	75.8	33.8	75.2	35.1	74.6	36.4
84	78.4	30.1	77.9	31.5	77.3	32.8	76.7	34.2	76.1	35.5	75.5	36.8
85	79.4	30.5	78.8	31.8	78.2	33.2	77.7	34.6	77.0	35.9	76.4	37.3
86	80.3	30.8	79.7	32.2	79.2	33.6	78.6	35.0	77.9	36.3	77.3	37.7
87	81.2	31.2	80.7	32.6	80.1	34.0	79.5	35.4	78.8	36.8	78.2	38.1
88	82.2	31.5	81.6	33.0	81.0	34.4	80.4	35.8	79.8	37.2	79.1	38.6
89	83.1	31.9	82.5	33.3	81.9	34.8	81.3	36.2	80.7	37.6	80.0	39.0
90	84.0	32.3	83.4	33.7	82.8	35.2	82.2	36.6	81.6	38.0	80.9	39.5
91	85.0	32.6	84.4	34.1	83.8	35.6	83.1	37.0	82.5	38.5	81.8	39.9
92	85.9	33.0	85.3	34.5	84.7	35.9	84.0	37.4	83.4	38.9	82.7	40.3
93	86.8	33.3	86.2	34.8	85.6	36.3	85.0	37.8	84.3	39.3	83.6	40.8
94	87.8	33.7	87.2	35.2	86.5	36.7	85.9	38.2	85.2	39.7	84.5	41.2
95	88.7	34.0	88.1	35.6	87.4	37.1	86.8	38.6	86.1	40.1	85.4	41.6
96	89.6	34.4	89.0	36.0	88.4	37.5	87.7	39.0	87.0	40.6	86.3	42.1
97	90.6	34.8	89.9	36.3	89.3	37.9	88.6	39.5	87.9	41.0	87.2	42.5
98	91.5	35.1	90.9	36.7	90.2	38.3	89.5	39.9	88.8	41.4	88.1	43.0
99	92.4	35.5	91.8	37.1	91.1	38.7	90.4	40.3	89.7	41.8	89.0	43.4
100	93.4	35.8	92.7	37.5	92.1	39.1	91.4	40.7	90.6	42.3	89.9	43.8
600	560.1	215.0	556.3	224.8	552.3	234.4	548.1	244.0	543.8	253.6	539.3	263.0
700	653.6	250.8	649.1	262.2	644.3	273.5	639.5	284.7	634.5	295.8	629.2	306.8
800	746.9	286.7	741.8	299.7	736.4	312.6	730.8	325.4	725.1	338.1	719.1	350.6
900	840.3	322.5	834.5	337.1	828.3	351.7	822.1	366.0	815.6	380.3	808.9	394.5
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(111°, 249°, 291°) 69°		(112°, 248°, 292°) 6 Pt. 68°		(113°, 247°, 293°) 67°		(114°, 246°, 294°) 66°		(115°, 245°, 295°) 5¾ Pt. 65°		(116°, 244°, 296°) 64°	

The 6-Pt. or 68° Courses are: E.N.E., W.N.W., E.S.E., W.S.W.

Dist.	27° (153°, 207°, 333°)		2½ Pt. 28° (152°, 208°, 332°)		29° (151°, 209°, 331°)		30° (150°, 210°, 330°)		2¾ Pt. 31° (149°, 211°, 329°)		32° (148°, 212°, 328°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	0.9	0.5	0.9	0.5	0.9	0.5	0.9	0.5	0.9	0.5	0.8	0.5
2	1.8	0.9	1.8	0.9	1.7	1.0	1.7	1.0	1.7	1.0	1.7	1.1
3	2.7	1.4	2.6	1.4	2.6	1.5	2.6	1.5	2.6	1.5	2.5	1.6
4	3.6	1.8	3.5	1.9	3.5	1.9	3.5	2.0	3.4	2.1	3.4	2.1
5	4.5	2.3	4.4	2.3	4.4	2.4	4.3	2.5	4.3	2.6	4.2	2.6
6	5.3	2.7	5.3	2.8	5.2	2.9	5.2	3.0	5.1	3.1	5.1	3.2
7	6.2	3.2	6.2	3.3	6.1	3.4	6.1	3.5	6.0	3.6	5.9	3.7
8	7.1	3.6	7.1	3.8	7.0	3.9	6.9	4.0	6.9	4.1	6.8	4.2
9	8.0	4.1	7.9	4.2	7.9	4.4	7.8	4.5	7.7	4.6	7.6	4.8
10	8.9	4.5	8.8	4.7	8.7	4.8	8.7	5.0	8.6	5.2	8.5	5.3
11	9.8	5.0	9.7	5.2	9.6	5.3	9.5	5.5	9.4	5.7	9.3	5.8
12	10.7	5.4	10.6	5.6	10.5	5.8	10.4	6.0	10.3	6.2	10.2	6.4
13	11.6	5.9	11.5	6.1	11.4	6.3	11.3	6.5	11.1	6.7	11.0	6.9
14	12.5	6.4	12.4	6.6	12.2	6.8	12.1	7.0	12.0	7.2	11.9	7.4
15	13.4	6.8	13.2	7.0	13.1	7.3	13.0	7.5	12.9	7.7	12.7	7.9
16	14.3	7.3	14.1	7.5	14.0	7.8	13.9	8.0	13.7	8.2	13.6	8.5
17	15.1	7.7	15.0	8.0	14.9	8.2	14.7	8.5	14.6	8.8	14.4	9.0
18	16.0	8.2	15.9	8.5	15.7	8.7	15.6	9.0	15.4	9.3	15.3	9.5
19	16.9	8.6	16.8	8.9	16.6	9.2	16.5	9.5	16.3	9.8	16.1	10.1
20	17.8	9.1	17.7	9.4	17.5	9.7	17.3	10.0	17.1	10.3	17.0	10.6
21	18.7	9.5	18.5	9.9	18.4	10.2	18.2	10.5	18.0	10.8	17.8	11.1
22	19.6	10.0	19.4	10.3	19.2	10.7	19.1	11.0	18.9	11.3	18.7	11.7
23	20.5	10.4	20.3	10.8	20.1	11.2	19.9	11.5	19.7	11.8	19.5	12.2
24	21.4	10.9	21.2	11.3	21.0	11.6	20.8	12.0	20.6	12.4	20.4	12.7
25	22.3	11.3	22.1	11.7	21.9	12.1	21.7	12.5	21.4	12.9	21.2	13.2
26	23.2	11.8	23.0	12.2	22.7	12.6	22.5	13.0	22.3	13.4	22.0	13.8
27	24.1	12.3	23.8	12.7	23.6	13.1	23.4	13.5	23.1	13.9	22.9	14.3
28	24.9	12.7	24.7	13.1	24.5	13.6	24.2	14.0	24.0	14.4	23.7	14.8
29	25.8	13.2	25.6	13.6	25.4	14.1	25.1	14.5	24.9	14.9	24.6	15.4
30	26.7	13.6	26.5	14.1	26.2	14.5	26.0	15.0	25.7	15.5	25.4	15.9
31	27.6	14.1	27.4	14.6	27.1	15.0	26.8	15.5	26.6	16.0	26.3	16.4
32	28.5	14.5	28.3	15.0	28.0	15.5	27.7	16.0	27.4	16.5	27.1	17.0
33	29.4	15.0	29.1	15.5	28.9	16.0	28.6	16.5	28.3	17.0	28.0	17.5
34	30.3	15.4	30.0	16.0	29.7	16.5	29.4	17.0	29.1	17.5	28.8	18.0
35	31.2	15.9	30.9	16.4	30.6	17.0	30.3	17.5	30.0	18.0	29.7	18.5
36	32.1	16.3	31.8	16.9	31.5	17.5	31.2	18.0	30.9	18.5	30.5	19.1
37	33.0	16.8	32.7	17.4	32.4	17.9	32.0	18.5	31.7	19.1	31.4	19.6
38	33.9	17.3	33.6	17.8	33.2	18.4	32.9	19.0	32.6	19.6	32.2	20.1
39	34.7	17.7	34.4	18.3	34.1	18.9	33.8	19.5	33.4	20.1	33.1	20.7
40	35.6	18.2	35.3	18.8	35.0	19.4	34.6	20.0	34.3	20.6	33.9	21.2
41	36.5	18.6	36.2	19.2	35.9	19.9	35.5	20.5	35.1	21.1	34.8	21.7
42	37.4	19.1	37.1	19.7	36.7	20.4	36.4	21.0	36.0	21.6	35.6	22.3
43	38.3	19.5	38.0	20.2	37.6	20.8	37.2	21.5	36.9	22.1	36.5	22.8
44	39.2	20.0	38.8	20.7	38.5	21.3	38.1	22.0	37.7	22.7	37.3	23.3
45	40.1	20.4	39.7	21.1	39.4	21.8	39.0	22.5	38.6	23.2	38.2	23.8
46	41.0	20.9	40.6	21.6	40.2	22.3	39.8	23.0	39.4	23.7	39.0	24.4
47	41.9	21.3	41.5	22.1	41.1	22.8	40.7	23.5	40.3	24.2	39.9	24.9
48	42.8	21.8	42.4	22.5	42.0	23.3	41.6	24.0	41.1	24.7	40.7	25.4
49	43.7	22.2	43.3	23.0	42.9	23.8	42.4	24.5	42.0	25.2	41.6	26.0
50	44.6	22.7	44.1	23.5	43.7	24.2	43.3	25.0	42.9	25.8	42.4	26.5
100	89.1	45.4	88.3	46.9	87.5	48.5	86.6	50.0	85.7	51.5	84.8	53.0
200	178.2	90.8	176.6	93.9	174.9	97.0	173.2	100.0	171.4	103.0	169.6	106.0
300	267.3	136.2	264.9	140.8	262.4	145.4	259.8	150.0	257.1	154.5	254.4	159.0
400	356.4	181.6	353.1	187.8	349.8	193.9	346.4	200.0	342.9	206.0	339.2	211.9
500	445.5	227.0	441.5	234.7	437.3	242.4	433.0	250.0	428.6	257.5	424.0	265.0
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(117°, 243°, 297°) 63°		(118°, 242°, 298°) 5½ Pt. 62°		(119°, 241°, 299°) 61°		(120°, 240°, 300°) 60°		(121°, 239°, 301°) 5¼ Pt. 59°		(122°, 238°, 302°) 58°	

Dist.	27° (153°, 207°, 333°)		2½ Pt. 28° (152°, 208°, 332°)		29° (151°, 209°, 331°)		30° (150°, 210°, 330°)		2¾ Pt. 31° (149°, 211°, 329°)		32° (148°, 212°, 328°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	45.4	23.2	45.0	23.9	44.6	24.7	44.2	25.5	43.7	26.3	43.3	27.0
52	46.3	23.6	45.9	24.4	45.5	25.2	45.0	26.0	44.6	26.8	44.1	27.6
53	47.2	24.1	46.8	24.9	46.4	25.7	45.9	26.5	45.4	27.3	44.9	28.1
54	48.1	24.5	47.7	25.4	47.2	26.2	46.8	27.0	46.3	27.8	45.8	28.6
55	49.0	25.0	48.6	25.8	48.1	26.7	47.6	27.5	47.1	28.3	46.6	29.1
56	49.9	25.4	49.4	26.3	49.0	27.1	48.5	28.0	48.0	28.8	47.5	29.7
57	50.8	25.9	50.3	26.8	49.9	27.6	49.4	28.5	48.9	29.4	48.3	30.2
58	51.7	26.3	51.2	27.2	50.7	28.1	50.2	29.0	49.7	29.9	49.2	30.7
59	52.6	26.8	52.1	27.7	51.6	28.6	51.1	29.5	50.6	30.4	50.0	31.3
60	53.5	27.2	53.0	28.2	52.5	29.1	52.0	30.0	51.4	30.9	50.9	31.8
61	54.4	27.7	53.9	28.6	53.4	29.6	52.8	30.5	52.3	31.4	51.7	32.3
62	55.2	28.1	54.7	29.1	54.2	30.1	53.7	31.0	53.1	31.9	52.6	32.9
63	56.1	28.6	55.6	29.6	55.1	30.5	54.6	31.5	54.0	32.4	53.4	33.4
64	57.0	29.1	56.5	30.0	56.0	31.0	55.4	32.0	54.9	33.0	54.3	33.9
65	57.9	29.5	57.4	30.5	56.9	31.5	56.3	32.5	55.7	33.5	55.1	34.4
66	58.8	30.0	58.3	31.0	57.7	32.0	57.2	33.0	56.6	34.0	56.0	35.0
67	59.7	30.4	59.2	31.5	58.6	32.5	58.0	33.5	57.4	34.5	56.8	35.5
68	60.6	30.9	60.0	31.9	59.5	33.0	58.9	34.0	58.3	35.0	57.7	36.0
69	61.5	31.3	60.9	32.4	60.3	33.5	59.8	34.5	59.1	35.5	58.5	36.6
70	62.4	31.8	61.8	32.9	61.2	33.9	60.6	35.0	60.0	36.1	59.4	37.1
71	63.3	32.2	62.7	33.3	62.1	34.4	61.5	35.5	60.9	36.6	60.2	37.6
72	64.2	32.7	63.6	33.8	63.0	34.9	62.4	36.0	61.7	37.1	61.1	38.2
73	65.0	33.1	64.5	34.3	63.8	35.4	63.2	36.5	62.6	37.6	61.9	38.7
74	65.9	33.6	65.3	34.7	64.7	35.9	64.1	37.0	63.4	38.1	62.8	39.2
75	66.8	34.0	66.2	35.2	65.6	36.4	65.0	37.5	64.3	38.6	63.6	39.7
76	67.7	34.5	67.1	35.7	66.5	36.8	65.8	38.0	65.1	39.1	64.5	40.3
77	68.6	35.0	68.0	36.1	67.3	37.3	66.7	38.5	66.0	39.7	65.3	40.8
78	69.5	35.4	68.9	36.6	68.2	37.8	67.5	39.0	66.9	40.2	66.1	41.3
79	70.4	35.9	69.8	37.1	69.1	38.3	68.4	39.5	67.7	40.7	67.0	41.9
80	71.3	36.3	70.6	37.6	70.0	38.8	69.3	40.0	68.6	41.2	67.8	42.4
81	72.2	36.8	71.5	38.0	70.8	39.3	70.1	40.5	69.4	41.7	68.7	42.9
82	73.1	37.2	72.4	38.5	71.7	39.8	71.0	41.0	70.3	42.2	69.5	43.5
83	74.0	37.7	73.3	39.0	72.6	40.2	71.9	41.5	71.1	42.7	70.4	44.0
84	74.8	38.1	74.2	39.4	73.5	40.7	72.7	42.0	72.0	43.3	71.2	44.5
85	75.7	38.6	75.1	39.9	74.3	41.2	73.6	42.5	72.9	43.8	72.1	45.0
86	76.6	39.0	75.9	40.4	75.2	41.7	74.5	43.0	73.7	44.3	72.9	45.6
87	77.5	39.5	76.8	40.8	76.1	42.2	75.3	43.5	74.6	44.8	73.8	46.1
88	78.4	40.0	77.7	41.3	77.0	42.7	76.2	44.0	75.4	45.3	74.6	46.6
89	79.3	40.4	78.6	41.8	77.8	43.1	77.1	44.5	76.3	45.8	75.5	47.2
90	80.2	40.9	79.5	42.3	78.7	43.6	77.9	45.0	77.1	46.4	76.3	47.7
91	81.1	41.3	80.3	42.7	79.6	44.1	78.8	45.5	78.0	46.9	77.2	48.2
92	82.0	41.8	81.2	43.2	80.5	44.6	79.7	46.0	78.9	47.4	78.0	48.8
93	82.9	42.2	82.1	43.7	81.3	45.1	80.5	46.5	79.7	47.9	78.9	49.3
94	83.8	42.7	83.0	44.1	82.2	45.6	81.4	47.0	80.6	48.4	79.7	49.8
95	84.6	43.1	83.9	44.6	83.1	46.1	82.3	47.5	81.4	48.9	80.6	50.3
96	85.5	43.6	84.8	45.1	84.0	46.5	83.1	48.0	82.3	49.4	81.4	50.9
97	86.4	44.0	85.6	45.5	84.8	47.0	84.0	48.5	83.1	50.0	82.3	51.4
98	87.3	44.5	86.5	46.0	85.7	47.5	84.9	49.0	84.0	50.5	83.1	51.9
99	88.2	44.9	87.4	46.5	86.6	48.0	85.7	49.5	84.9	51.0	84.0	52.5
100	89.1	45.4	88.3	46.9	87.5	48.5	86.6	50.0	85.7	51.5	84.8	53.0
600	534.6	272.4	529.8	281.7	524.8	290.9	519.6	300.0	514.3	309.0	508.8	318.0
700	623.7	317.8	618.0	328.6	612.2	339.4	606.1	350.0	600.1	360.4	593.6	371.0
800	712.9	363.2	706.3	375.6	699.7	387.9	692.8	400.0	685.8	412.0	678.4	423.9
900	801.9	408.5	794.5	422.5	787.0	436.3	779.3	450.0	771.4	463.4	763.2	476.8
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(117°, 243°, 297°) 63°		(118°, 242°, 298°) 5½ Pt. 62°		(119°, 241°, 299°) 61°		(120°, 240° 300°) 60°		(121°, 239°, 301°) 5¼ Pt. 59°		(122°, 238°, 302°) 58°	

Dist.	33° (147°, 213°, 327°)		3 Pt 34° (146°, 214°, 326°)		35° (145°, 215°, 325°)		36° (144°, 216°, 324°)		3¼ Pt. 37° (143°, 217°, 323°)		38° (142°, 218°, 322°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	0.8	0.5	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6
2	1.7	1.1	1.7	1.1	1.6	1.1	1.6	1.2	1.6	1.2	1.6	1.2
3	2.5	1.6	2.5	1.7	2.5	1.7	2.4	1.8	2.4	1.8	2.4	1.8
4	3.4	2.2	3.3	2.2	3.3	2.3	3.2	2.4	3.2	2.4	3.2	2.5
5	4.2	2.7	4.1	2.8	4.1	2.9	4.0	2.9	4.0	3.0	3.9	3.1
6	5.0	3.3	5.0	3.4	4.9	3.4	4.9	3.5	4.8	3.6	4.7	3.7
7	5.9	3.8	5.8	3.9	5.7	4.0	5.7	4.1	5.6	4.2	5.5	4.3
8	6.7	4.4	6.6	4.5	6.6	4.6	6.5	4.7	6.4	4.8	6.3	4.9
9	7.5	4.9	7.5	5.0	7.4	5.2	7.3	5.3	7.2	5.4	7.1	5.5
10	8.4	5.4	8.3	5.6	8.2	5.7	8.1	5.9	8.0	6.0	7.9	6.2
11	9.2	6.0	9.1	6.2	9.0	6.3	8.9	6.5	8.8	6.6	8.7	6.8
12	10.1	6.5	9.9	6.7	9.8	6.9	9.7	7.1	9.6	7.2	9.5	7.4
13	10.9	7.1	10.8	7.3	10.6	7.5	10.5	7.6	10.4	7.8	10.2	8.0
14	11.7	7.6	11.6	7.8	11.5	8.0	11.3	8.2	11.2	8.4	11.0	8.6
15	12.6	8.2	12.4	8.4	12.3	8.6	12.1	8.8	12.0	9.0	11.8	9.2
16	13.4	8.7	13.3	8.9	13.1	9.2	12.9	9.4	12.8	9.6	12.6	9.9
17	14.3	9.3	14.1	9.5	13.9	9.8	13.8	10.0	13.6	10.2	13.4	10.5
18	15.1	9.8	14.9	10.1	14.7	10.3	14.6	10.6	14.4	10.8	14.2	11.1
19	15.9	10.3	15.8	10.6	15.6	10.9	15.4	11.2	15.2	11.4	15.0	11.7
20	16.8	10.9	16.6	11.2	16.4	11.5	16.2	11.8	16.0	12.0	15.8	12.3
21	17.6	11.4	17.4	11.7	17.2	12.0	17.0	12.3	16.8	12.6	16.5	12.9
22	18.5	12.0	18.2	12.3	18.0	12.6	17.8	12.9	17.6	13.2	17.3	13.5
23	19.3	12.5	19.1	12.9	18.8	13.2	18.6	13.5	18.4	13.8	18.1	14.2
24	20.1	13.1	19.9	13.4	19.7	13.8	19.4	14.1	19.2	14.4	18.9	14.8
25	21.0	13.6	20.7	14.0	20.5	14.3	20.2	14.7	20.0	15.0	19.7	15.4
26	21.8	14.2	21.6	14.5	21.3	14.9	21.0	15.3	20.8	15.6	20.5	16.0
27	22.6	14.7	22.4	15.1	22.1	15.5	21.8	15.9	21.6	16.2	21.3	16.6
28	23.5	15.2	23.2	15.7	22.9	16.1	22.7	16.5	22.4	16.9	22.1	17.2
29	24.3	15.8	24.0	16.2	23.8	16.6	23.5	17.0	23.2	17.5	22.9	17.9
30	25.2	16.3	24.9	16.8	24.6	17.2	24.3	17.6	24.0	18.1	23.6	18.5
31	26.0	16.9	25.7	17.3	25.4	17.8	25.1	18.2	24.8	18.7	24.4	19.1
32	26.8	17.4	26.5	17.9	26.2	18.4	25.9	18.8	25.6	19.3	25.2	19.7
33	27.7	18.0	27.4	18.5	27.0	18.9	26.7	19.4	26.4	19.9	26.0	20.3
34	28.5	18.5	28.2	19.0	27.9	19.5	27.5	20.0	27.2	20.5	26.8	20.9
35	29.4	19.1	29.0	19.6	28.7	20.1	28.3	20.6	28.0	21.1	27.6	21.5
36	30.2	19.6	29.8	20.1	29.5	20.6	29.1	21.2	28.8	21.7	28.4	22.2
37	31.0	20.2	30.7	20.7	30.3	21.2	29.9	21.7	29.5	22.3	29.2	22.8
38	31.9	20.7	31.5	21.2	31.1	21.8	30.7	22.3	30.3	22.9	29.9	23.4
39	32.7	21.2	32.3	21.8	31.9	22.4	31.6	22.9	31.1	23.5	30.7	24.0
40	33.5	21.8	33.2	22.4	32.8	22.9	32.4	23.5	31.9	24.1	31.5	24.6
41	34.4	22.3	34.0	22.9	33.6	23.5	33.2	24.1	32.7	24.7	32.3	25.2
42	35.2	22.9	34.8	23.5	34.4	24.1	34.0	24.7	33.5	25.3	33.1	25.9
43	36.1	23.4	35.6	24.0	35.2	24.7	34.8	25.3	34.3	25.9	33.9	26.5
44	36.9	24.0	36.5	24.6	36.0	25.2	35.6	25.9	35.1	26.5	34.7	27.1
45	37.7	24.5	37.3	25.2	36.9	25.8	36.4	26.5	35.9	27.1	35.5	27.7
46	38.6	25.1	38.1	25.7	37.7	26.4	37.2	27.0	36.7	27.7	36.2	28.3
47	39.4	25.6	39.0	26.3	38.5	27.0	38.0	27.6	37.5	28.3	37.0	28.9
48	40.3	26.1	39.8	26.8	39.3	27.5	38.8	28.2	38.3	28.9	37.8	29.6
49	41.1	26.7	40.6	27.4	40.1	28.1	39.6	28.8	39.1	29.5	38.6	30.2
50	41.9	27.2	41.5	28.0	41.0	28.7	40.5	29.4	39.9	30.1	39.4	30.8
100	83.9	54.5	82.9	55.9	81.9	57.4	80.9	58.8	79.9	60.2	78.8	61.6
200	167.7	108.9	165.8	111.8	163.8	114.7	161.8	117.6	159.7	120.4	157.6	123.1
300	251.6	163.4	248.7	167.8	245.7	172.1	242.7	176.3	239.6	180.5	236.4	184.7
400	335.5	217.8	331.6	223.7	327.7	229.4	323.6	235.1	319.4	240.7	315.2	246.3
500	419.3	272.3	414.5	279.6	409.6	286.8	404.5	293.9	399.3	300.9	394.0	307.8
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(123°, 237°, 303°) 57°		(124°, 236°, 304°) 5 Pt. 56°		(125°, 235°, 305°) 55°		(126°, 234°, 306°) 54°		(127°, 233°, 307°) 4¾ Pt. 53°		(128°, 232°, 308°) 52°	

The 3-Pt. or 34° Courses are: N.E. by N., N.W. by N., S.E. by S., S.W. by S.

Dist.	33° (147°, 213°, 327°)		3 Pt. 34° (146°, 214°, 326°)		35° (145°, 215°, 325°)		36° (144°, 216°, 324°)		3¼ Pt. 37° (143°, 217°, 323°)		38° (142°, 218°, 322°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	42.8	27.8	42.3	28.5	41.8	29.3	41.3	30.0	40.7	30.7	40.2	31.4
52	43.6	28.3	43.1	29.1	42.6	29.8	42.1	30.6	41.5	31.3	41.0	32.0
53	44.4	28.9	43.9	29.6	43.4	30.4	42.9	31.2	42.3	31.9	41.8	32.6
54	45.3	29.4	44.8	30.2	44.2	31.0	43.7	31.7	43.1	32.5	42.6	33.2
55	46.1	30.0	45.6	30.8	45.1	31.5	44.5	32.3	43.9	33.1	43.3	33.9
56	47.0	30.5	46.4	31.3	45.9	32.1	45.3	32.9	44.7	33.7	44.1	34.5
57	47.8	31.0	47.3	31.9	46.7	32.7	46.1	33.5	45.5	34.3	44.9	35.1
58	48.6	31.6	48.1	32.4	47.5	33.3	46.9	34.1	46.3	34.9	45.7	35.7
59	49.5	32.1	48.9	33.0	48.3	33.8	47.7	34.7	47.1	35.5	46.5	36.3
60	50.3	32.7	49.7	33.6	49.1	34.4	48.5	35.3	47.9	36.1	47.3	36.9
61	51.2	33.2	50.6	34.1	50.0	35.0	49.4	35.9	48.7	36.7	48.1	37.6
62	52.0	33.8	51.4	34.7	50.8	35.6	50.2	36.4	49.5	37.3	48.9	38.2
63	52.8	34.3	52.2	35.2	51.6	36.1	51.0	37.0	50.3	37.9	49.6	38.8
64	53.7	34.9	53.1	35.8	52.4	36.7	51.8	37.6	51.1	38.5	50.4	39.4
65	54.5	35.4	53.9	36.3	53.2	37.3	52.6	38.2	51.9	39.1	51.2	40.0
66	55.4	35.9	54.7	36.9	54.1	37.9	53.4	38.8	52.7	39.7	52.0	40.6
67	56.2	36.5	55.5	37.5	54.9	38.4	54.2	39.4	53.5	40.3	52.8	41.2
68	57.0	37.0	56.4	38.0	55.7	39.0	55.0	40.0	54.3	40.9	53.6	41.9
69	57.9	37.6	57.2	38.6	56.5	39.6	55.8	40.6	55.1	41.5	54.4	42.5
70	58.7	38.1	58.0	39.1	57.3	40.2	56.6	41.1	55.9	42.1	55.2	43.1
71	59.5	38.7	58.9	39.7	58.2	40.7	57.4	41.7	56.7	42.7	55.9	43.7
72	60.4	39.2	59.7	40.3	59.0	41.3	58.2	42.3	57.5	43.3	56.7	44.3
73	61.2	39.8	60.5	40.8	59.8	41.9	59.1	42.9	58.3	43.9	57.5	44.9
74	62.1	40.3	61.3	41.4	60.6	42.4	59.9	43.5	59.1	44.5	58.3	45.6
75	62.9	40.8	62.2	41.9	61.4	43.0	60.7	44.1	59.9	45.1	59.1	46.2
76	63.7	41.4	63.0	42.5	62.3	43.6	61.5	44.7	60.7	45.7	59.9	46.8
77	64.6	41.9	63.8	43.1	63.1	44.2	62.3	45.3	61.5	46.3	60.7	47.4
78	65.4	42.5	64.7	43.6	63.9	44.7	63.1	45.8	62.3	46.9	61.5	48.0
79	66.3	43.0	65.5	44.2	64.7	45.3	63.9	46.4	63.1	47.5	62.3	48.6
80	67.1	43.6	66.3	44.7	65.5	45.9	64.7	47.0	63.9	48.1	63.0	49.3
81	67.9	44.1	67.2	45.3	66.4	46.5	65.5	47.6	64.7	48.7	63.8	49.9
82	68.8	44.7	68.0	45.9	67.2	47.0	66.3	48.2	65.5	49.3	64.6	50.5
83	69.6	45.2	68.8	46.4	68.0	47.6	67.1	48.8	66.3	50.0	65.4	51.1
84	70.4	45.7	69.6	47.0	68.8	48.2	68.0	49.4	67.1	50.6	66.2	51.7
85	71.3	46.3	70.5	47.5	69.6	48.8	68.8	50.0	67.9	51.2	67.0	52.3
86	72.1	46.8	71.3	48.1	70.4	49.3	69.6	50.5	68.7	51.8	67.8	52.9
87	73.0	47.4	72.1	48.6	71.3	49.9	70.4	51.1	69.5	52.4	68.6	53.6
88	73.8	47.9	73.0	49.2	72.1	50.5	71.2	51.7	70.3	53.0	69.3	54.2
89	74.6	48.5	73.8	49.8	72.9	51.0	72.0	52.3	71.1	53.6	70.1	54.8
90	75.5	49.0	74.6	50.3	73.7	51.6	72.8	52.9	71.9	54.2	70.9	55.4
91	76.3	49.6	75.4	50.9	74.5	52.2	73.6	53.5	72.7	54.8	71.7	56.0
92	77.2	50.1	76.3	51.4	75.4	52.8	74.4	54.1	73.5	55.4	72.5	56.6
93	78.0	50.7	77.1	52.0	76.2	53.3	75.2	54.7	74.3	56.0	73.3	57.3
94	78.8	51.2	77.9	52.6	77.0	53.9	76.0	55.3	75.1	56.6	74.1	57.9
95	79.7	51.7	78.8	53.1	77.8	54.5	76.9	55.8	75.9	57.2	74.9	58.5
96	80.5	52.3	79.6	53.7	78.6	55.1	77.7	56.4	76.7	57.8	75.6	59.1
97	81.4	52.8	80.4	54.2	79.5	55.6	78.5	57.0	77.5	58.4	76.4	59.7
98	82.2	53.4	81.2	54.8	80.3	56.2	79.3	57.6	78.3	59.0	77.2	60.3
99	83.0	53.9	82.1	55.4	81.1	56.8	80.1	58.2	79.1	59.6	78.0	61.0
100	83.9	54.5	82.9	55.9	81.9	57.4	80.9	58.8	79.9	60.2	78.8	61.6
600	503.2	326.8	497.4	335.5	491.5	344.1	485.4	352.7	479.2	361.1	472.8	369.4
700	587.0	381.3	580.3	391.4	573.5	401.5	566.2	411.4	559.0	421.3	551.6	430.8
800	671.0	435.7	663.3	447.4	655.4	458.8	647.3	470.2	638.9	481.5	630.4	492.5
900	754.8	490.1	746.1	503.2	737.2	516.2	728.1	528.9	718.6	541.7	709.1	554.0
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(123°, 237°, 303°) 57°		(124°, 236°, 304°) 5 Pt. 56°		(125°, 235°, 305°) 55°		(126°, 234°, 306°) 54°		(127°, 233°, 307°) 4¾ Pt. 53°		(128°, 232°, 308°) 52°	

The 5-Pt. or 56° Courses are: N.E. by E., S.E. by E., N.W. by W., S.W. by W.

Dist.	3½ Pt. **39°** (141°, 219°, 321°)		**40°** (140°, 220°, 320°)		**41°** (139°, 221°, 319°)		3¾ Pt. **42°** (138°, 222°, 318°)		**43°** (137°, 223°, 317°)		**44°** (136°, 224°, 316°)		4 Pt. **45°** (135°, 225°, 315°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
1	0.8	0.6	0.8	0.6	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
2	1.6	1.3	1.5	1.3	1.5	1.3	1.5	1.3	1.5	1.4	1.4	1.4	1.4	1.4
3	2.3	1.9	2.3	1.9	2.3	2.0	2.2	2.0	2.2	2.0	2.2	2.1	2.1	2.1
4	3.1	2.5	3.1	2.6	3.0	2.6	3.0	2.7	2.9	2.7	2.9	2.8	2.8	2.8
5	3.9	3.1	3.8	3.2	3.8	3.3	3.7	3.3	3.7	3.4	3.6	3.5	3.5	3.5
6	4.7	3.8	4.6	3.9	4.5	3.9	4.5	4.0	4.4	4.1	4.3	4.2	4.2	4.2
7	5.4	4.4	5.4	4.5	5.3	4.6	5.2	4.7	5.1	4.8	5.0	4.9	4.9	4.9
8	6.2	5.0	6.1	5.1	6.0	5.2	5.9	5.4	5.9	5.5	5.8	5.6	5.7	5.7
9	7.0	5.7	6.9	5.8	6.8	5.9	6.7	6.0	6.6	6.1	6.5	6.3	6.4	6.4
10	7.8	6.3	7.7	6.4	7.5	6.6	7.4	6.7	7.3	6.8	7.2	6.9	7.1	7.1
11	8.5	6.9	8.4	7.1	8.3	7.2	8.2	7.4	8.0	7.5	7.9	7.6	7.8	7.8
12	9.3	7.6	9.2	7.7	9.1	7.9	8.9	8.0	8.8	8.2	8.6	8.3	8.5	8.5
13	10.1	8.2	10.0	8.4	9.8	8.5	9.7	8.7	9.5	8.9	9.4	9.0	9.2	9.2
14	10.9	8.8	10.7	9.0	10.6	9.2	10.4	9.4	10.2	9.5	10.1	9.7	9.9	9.9
15	11.7	9.4	11.5	9.6	11.3	9.8	11.1	10.0	11.0	10.2	10.8	10.4	10.6	10.6
16	12.4	10.1	12.3	10.3	12.1	10.5	11.9	10.7	11.7	10.9	11.5	11.1	11.3	11.3
17	13.2	10.7	13.0	10.9	12.8	11.2	12.6	11.4	12.4	11.6	12.2	11.8	12.0	12.0
18	14.0	11.3	13.8	11.6	13.6	11.8	13.4	12.0	13.2	12.3	12.9	12.5	12.7	12.7
19	14.8	12.0	14.6	12.2	14.3	12.5	14.1	12.7	13.9	13.0	13.7	13.2	13.4	13.4
20	15.5	12.6	15.3	12.9	15.1	13.1	14.9	13.4	14.6	13.6	14.4	13.9	14.1	14.1
21	16.3	13.2	16.1	13.5	15.8	13.8	15.6	14.1	15.4	14.3	15.1	14.6	14.8	14.8
22	17.1	13.8	16.9	14.1	16.6	14.4	16.3	14.7	16.1	15.0	15.8	15.3	15.6	15.6
23	17.9	14.5	17.6	14.8	17.4	15.1	17.1	15.4	16.8	15.7	16.5	16.0	16.3	16.3
24	18.7	15.1	18.4	15.4	18.1	15.7	17.8	16.1	17.6	16.4	17.3	16.7	17.0	17.0
25	19.4	15.7	19.2	16.1	18.9	16.4	18.6	16.7	18.3	17.0	18.0	17.4	17.7	17.7
26	20.2	16.4	19.9	16.7	19.6	17.1	19.3	17.4	19.0	17.7	18.7	18.1	18.4	18.4
27	21.0	17.0	20.7	17.4	20.4	17.7	20.1	18.1	19.7	18.4	19.4	18.8	19.1	19.1
28	21.8	17.6	21.4	18.0	21.1	18.4	20.8	18.7	20.5	19.1	20.1	19.5	19.8	19.8
29	22.5	18.3	22.2	18.6	21.9	19.0	21.6	19.4	21.2	19.8	20.9	20.1	20.5	20.5
30	23.3	18.9	23.0	19.3	22.6	19.7	22.3	20.1	21.9	20.5	21.6	20.8	21.2	21.2
31	24.1	19.5	23.7	19.9	23.4	20.3	23.0	20.7	22.7	21.1	22.3	21.5	21.9	21.9
32	24.9	20.1	24.5	20.6	24.2	21.0	23.8	21.4	23.4	21.8	23.0	22.2	22.6	22.6
33	25.6	20.8	25.3	21.2	24.9	21.6	24.5	22.1	24.1	22.5	23.7	22.9	23.3	23.3
34	26.4	21.4	26.0	21.9	25.7	22.3	25.3	22.8	24.9	23.2	24.5	23.6	24.0	24.0
35	27.2	22.0	26.8	22.5	26.4	23.0	26.0	23.4	25.6	23.9	25.2	24.3	24.7	24.7
36	28.0	22.7	27.6	23.1	27.2	23.6	26.8	24.1	26.3	24.6	25.9	25.0	25.5	25.5
37	28.8	23.3	28.3	23.8	27.9	24.3	27.5	24.8	27.1	25.2	26.6	25.7	26.2	26.2
38	29.5	23.9	29.1	24.4	28.7	24.9	28.2	25.4	27.8	25.9	27.3	26.4	26.9	26.9
39	30.3	24.5	29.9	25.1	29.4	25.6	29.0	26.1	28.5	26.6	28.1	27.1	27.6	27.6
40	31.1	25.2	30.6	25.7	30.2	26.2	29.7	26.8	29.3	27.3	28.8	27.8	28.3	28.3
41	31.9	25.8	31.4	26.4	30.9	26.9	30.5	27.4	30.0	28.0	29.5	28.5	29.0	29.0
42	32.6	26.4	32.2	27.0	31.7	27.6	31.2	28.1	30.7	28.6	30.2	29.2	29.7	29.7
43	33.4	27.1	32.9	27.6	32.5	28.2	32.0	28.8	31.4	29.3	30.9	29.9	30.4	30.4
44	34.2	27.7	33.7	28.3	33.2	28.9	32.7	29.4	32.2	30.0	31.7	30.6	31.1	31.1
45	35.0	28.3	34.5	28.9	34.0	29.5	33.4	30.1	32.9	30.7	32.4	31.3	31.8	31.8
46	35.7	28.9	35.2	29.6	34.7	30.2	34.2	30.8	33.6	31.4	33.1	32.0	32.5	32.5
47	36.5	29.6	36.0	30.2	35.5	30.8	34.9	31.4	34.4	32.1	33.8	32.6	33.2	33.2
48	37.3	30.2	36.8	30.9	36.2	31.5	35.7	32.1	35.1	32.7	34.5	33.3	33.9	33.9
49	38.1	30.8	37.5	31.5	37.0	32.1	36.4	32.8	35.8	33.4	35.2	34.0	34.6	34.6
50	38.9	31.5	38.3	32.1	37.7	32.8	37.2	33.5	36.6	34.1	36.0	34.7	35.4	35.4
100	77.7	62.9	76.6	64.3	75.5	65.6	74.3	66.9	73.1	68.2	71.9	69.5	70.7	70.7
200	155.4	125.9	153.2	128.6	150.9	131.2	148.6	133.8	146.3	136.4	143.9	138.9	141.4	141.4
300	233.1	188.8	229.8	192.8	226.4	196.8	222.9	200.7	219.4	204.6	215.8	208.4	212.1	212.1
400	310.9	251.7	306.4	257.1	301.9	262.4	297.3	267.7	292.6	272.8	287.7	277.9	282.8	282.8
500	388.6	314.7	383.0	321.4	377.3	328.0	371.6	334.6	365.7	341.0	359.7	347.3	353.5	353.5
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(129°, 231°, 309°) 4½ Pt. **51°**		(130°, 230°, 310°) **50°**		(131°, 229°, 311° **49°**		(132°, 228°, 312°) 4¼ Pt. **48°**		(133°, 227°, 313°) **47°**		(134°, 226°, 314°) **46°**		(135°, 225°, 315°) 4 Pt. **45°**	

The 4-Pt. or 45° Courses are: N.E., N.W., S.E., S.W.

Dist.	3½ Pt. **39°** (141°, 219°, 321°)		**40°** (140°, 220°, 320°)		**41°** (139°, 221°, 319°)		3¾ Pt. **42°** (138°, 222°, 318°)		**43°** (137°, 223°, 317°)		**44°** (136°, 224°, 316°)		4 Pt. **45°** (135°, 225°, 315°)	
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
51	39.6	32.1	39.1	32.8	38.5	33.5	37.9	34.1	37.3	34.8	36.7	35.4	36.1	36.1
52	40.4	32.7	39.8	33.4	39.2	34.1	38.6	34.8	38.0	35.5	37.4	36.1	36.8	36.8
53	41.2	33.4	40.6	34.1	40.0	34.8	39.4	35.5	38.8	36.1	38.1	36.8	37.5	37.5
54	42.0	34.0	41.4	34.7	40.8	35.4	40.1	36.1	39.5	36.8	38.8	37.5	38.2	38.2
55	42.7	34.6	42.1	35.4	41.5	36.1	40.9	36.8	40.2	37.5	39.6	38.2	38.9	38.9
56	43.5	35.2	42.9	36.0	42.3	36.7	41.6	37.5	41.0	38.2	40.3	38.9	39.6	39.6
57	44.3	35.9	43.7	36.6	43.0	37.4	42.4	38.1	41.7	38.9	41.0	39.6	40.3	40.3
58	45.1	36.5	44.4	37.3	43.8	38.1	43.1	38.8	42.4	39.6	41.7	40.3	41.0	41.0
59	45.9	37.1	45.2	37.9	44.5	38.7	43.8	39.5	43.1	40.2	42.4	41.0	41.7	41.7
60	46.6	37.8	46.0	38.6	45.3	39.4	44.6	40.1	43.9	40.9	43.2	41.7	42.4	42.4
61	47.4	38.4	46.7	39.2	46.0	40.0	45.3	40.8	44.6	41.6	43.9	42.4	43.1	43.1
62	48.2	39.0	47.5	39.9	46.8	40.7	46.1	41.5	45.3	42.3	44.6	43.1	43.8	43.8
63	49.0	39.6	48.3	40.5	47.5	41.3	46.8	42.2	46.1	43.0	45.3	43.8	44.5	44.5
64	49.7	40.3	49.0	41.1	48.3	42.0	47.6	42.8	46.8	43.6	46.0	44.5	45.3	45.3
65	50.5	40.9	49.8	41.8	49.1	42.6	48.3	43.5	47.5	44.3	46.8	45.2	46.0	46.0
66	51.3	41.5	50.6	42.4	49.8	43.3	49.0	44.2	48.3	45.0	47.5	45.8	46.7	46.7
67	52.1	42.2	51.3	43.1	50.6	44.0	49.8	44.8	49.0	45.7	48.2	46.5	47.4	47.4
68	52.8	42.8	52.1	43.7	51.3	44.6	50.5	45.5	49.7	46.4	48.9	47.2	48.1	48.1
69	53.6	43.4	52.9	44.4	52.1	45.3	51.3	46.2	50.5	47.1	49.6	47.9	48.8	48.8
70	54.4	44.1	53.6	45.0	52.8	45.9	52.0	46.8	51.2	47.7	50.4	48.6	49.5	49.5
71	55.2	44.7	54.4	45.6	53.6	46.6	52.8	47.5	51.9	48.4	51.1	49.3	50.2	50.2
72	56.0	45.3	55.2	46.3	54.3	47.2	53.5	48.2	52.7	49.1	51.8	50.0	50.9	50.9
73	56.7	45.9	55.9	46.9	55.1	47.9	54.2	48.8	53.4	49.8	52.5	50.7	51.6	51.6
74	57.5	46.6	56.7	47.6	55.8	48.5	55.0	49.5	54.1	50.5	53.2	51.4	52.3	52.3
75	58.3	47.2	57.5	48.2	56.6	49.2	55.7	50.2	54.9	51.1	54.0	52.1	53.0	53.0
76	59.1	47.8	58.2	48.9	57.4	49.9	56.5	50.9	55.6	51.8	54.7	52.8	53.7	53.7
77	59.8	48.5	59.0	49.5	58.1	50.5	57.2	51.5	56.3	52.5	55.4	53.5	54.4	54.4
78	60.6	49.1	59.8	50.1	58.9	51.2	58.0	52.2	57.0	53.2	56.1	54.2	55.2	55.2
79	61.4	49.7	60.5	50.8	59.6	51.8	58.7	52.9	57.8	53.9	56.8	54.9	55.9	55.9
80	62.2	50.3	61.3	51.4	60.4	52.5	59.5	53.5	58.5	54.6	57.5	55.6	56.6	56.6
81	62.9	51.0	62.0	52.1	61.1	53.1	60.2	54.2	59.2	55.2	58.3	56.3	57.3	57.3
82	63.7	51.6	62.8	52.7	61.9	53.8	60.9	54.9	60.0	55.9	59.0	57.0	58.0	58.0
83	64.5	52.2	63.6	53.4	62.6	54.5	61.7	55.5	60.7	56.6	59.7	57.7	58.7	58.7
84	65.3	52.9	64.3	54.0	63.4	55.1	62.4	56.2	61.4	57.3	60.4	58.4	59.4	59.4
85	66.1	53.5	65.1	54.6	64.2	55.8	63.2	56.9	62.2	58.0	61.1	59.0	60.1	60.1
86	66.8	54.1	65.9	55.3	64.9	56.4	63.9	57.5	62.9	58.7	61.9	59.7	60.8	60.8
87	67.6	54.8	66.6	55.9	65.7	57.1	64.7	58.2	63.6	59.3	62.6	60.4	61.5	61.5
88	68.4	55.4	67.4	56.6	66.4	57.7	65.4	58.9	64.4	60.0	63.3	61.1	62.2	62.2
89	69.2	56.0	68.2	57.2	67.2	58.4	66.1	59.6	65.1	60.7	64.0	61.8	62.9	62.9
90	69.9	56.6	68.9	57.9	67.9	59.0	66.9	60.2	65.8	61.4	64.7	62.5	63.6	63.6
91	70.7	57.3	69.7	58.5	68.7	59.7	67.6	60.9	66.6	62.1	65.5	63.2	64.3	64.3
92	71.5	57.9	70.5	59.1	69.4	60.4	68.4	61.6	67.3	62.7	66.2	63.9	65.1	65.1
93	72.3	58.5	71.2	59.8	70.2	61.0	69.1	62.2	68.0	63.4	66.9	64.6	65.8	65.8
94	73.1	59.2	72.0	60.4	70.9	61.7	69.9	62.9	68.7	64.1	67.6	65.3	66.5	66.5
95	73.8	59.8	72.8	61.1	71.7	62.3	70.6	63.6	69.5	64.8	68.3	66.0	67.2	67.2
96	74.6	60.4	73.5	61.7	72.5	63.0	71.3	64.2	70.2	65.5	69.1	66.7	67.9	67.9
97	75.4	61.0	74.3	62.4	73.2	63.6	72.1	64.9	70.9	66.2	69.8	67.4	68.6	68.6
98	76.2	61.7	75.1	63.0	74.0	64.3	72.8	65.6	71.7	66.8	70.5	68.1	69.3	69.3
99	76.9	62.3	75.8	63.6	74.7	64.9	73.6	66.2	72.4	67.5	71.2	68.8	70.0	70.0
100	77.7	62.9	76.6	64.3	75.5	65.6	74.3	66.9	73.1	68.2	71.9	69.5	70.7	70.7
600	466.3	377.6	459.6	385.7	452.8	393.6	445.9	401.5	438.8	409.2	431.6	416.8	424.3	424.3
700	543.9	440.6	536.3	450.0	528.3	459.2	520.2	468.4	511.9	477.4	503.5	486.3	495.0	495.0
800	621.8	503.5	613.0	514.2	603.9	524.8	594.6	535.3	585.1	545.6	575.4	555.8	565.7	565.7
900	699.3	566.3	689.5	578.5	679.2	590.3	668.8	602.2	658.2	613.8	647.3	625.2	636.3	636.3
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
	(129°, 231°, 309°) 4½ Pt. **51°**		(130°, 230°, 310°) **50°**		(131°, 229°, 311°) **49°**		(132°, 228°, 312°) 4¼ Pt. **48°**		(133°, 227°, 313°) **47°**		(134°, 226°, 314°) **46°**		(135°, 225°, 315°) 4 Pt. **45°**	

The 4-Pt. or 45° Courses are: N.E., N.W., S.E., S.W.

Table 2

TO CHANGE LONG. DIFF. INTO DEP., **SUBTRACT** TABULAR NUMBER FROM LONG. DIFF.

Long. Diff. or Dep.	Middle Latitude														
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3
9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
11	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4
12	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
13	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4
14	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
15	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
16	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5
17	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6
18	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6
19	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.6
20	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7
21	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7
22	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.7
23	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8
24	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8
25	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.9
26	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
27	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
28	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0
29	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0
30	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
31	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1
32	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1
33	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1
34	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2
35	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2
36	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.7	0.8	0.9	1.1	1.2
37	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.3
38	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3
39	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.3
40	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4
41	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.2	1.4
42	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.2	1.4
43	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.8	0.9	1.1	1.3	1.5
44	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.1	1.3	1.5
45	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.7	0.8	1.0	1.2	1.3	1.5
46	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.8	1.0	1.2	1.4	1.6
47	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6
48	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6
49	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.5	1.7
50	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.3	1.5	1.7
100	0.0	0.1	0.1	0.2	0.4	0.5	0.7	1.0	1.2	1.5	1.8	2.2	2.6	3.0	3.4
200	0.0	0.1	0.3	0.5	0.8	1.1	1.5	1.9	2.5	3.0	3.7	4.4	5.1	5.9	6.8
300	0.0	0.2	0.4	0.7	1.1	1.6	2.2	2.9	3.7	4.6	5.5	6.6	7.7	8.9	10.2
400	0.1	0.2	0.6	1.0	1.5	2.2	3.0	3.9	4.9	6.1	7.4	8.7	10.2	11.9	13.7
500	0.1	0.3	0.7	1.2	1.9	2.7	3.7	4.9	6.2	7.6	9.2	10.9	12.8	14.9	17.0
Factor	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04

TO CHANGE DEP. INTO LONG. DIFF., MULTIPLY TABULAR NUMBER BY FACTOR AT FOOT OF COLUMN, AND **ADD** PRODUCT TO DEP.

TO CHANGE LONG. DIFF. INTO DEP. **SUBTRACT** TABULAR NUMBER FROM LONG. DIFF.

Long. Diff. or Dep.	Middle Latitude														
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°
51	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.3	1.5	1.7
52	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.1	1.3	1.5	1.8
53	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.6	1.8
54	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.6	1.8
55	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.6	1.9
56	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.0	1.2	1.4	1.7	1.9
57	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.5	1.7	1.9
58	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	2.0
59	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.8	2.0
60	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.8	2.0
61	0.0	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.3	1.6	1.8	2.1
62	0.0	0.0	0.1	0.2	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.4	1.6	1.8	2.1
63	0.0	0.0	0.1	0.2	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.4	1.6	1.9	2.1
64	0.0	0.0	0.1	0.2	0.2	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.6	1.9	2.2
65	0.0	0.0	0.1	0.2	0.2	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.7	1.9	2.2
66	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.7	2.0	2.2
67	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.5	1.7	2.0	2.3
68	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.5	1.7	2.0	2.3
69	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.3	1.5	1.8	2.0	2.4
70	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.1	2.4
71	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.6	1.8	2.1	2.4
72	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.6	1.8	2.1	2.5
73	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.6	1.9	2.2	2.5
74	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.4	1.6	1.9	2.2	2.5
75	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.4	1.6	1.9	2.2	2.6
76	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.4	1.7	1.9	2.3	2.6
77	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.4	1.7	2.0	2.3	2.6
78	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.7	2.0	2.3	2.7
79	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.0	2.3	2.7
80	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.4	2.7
81	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.8	2.1	2.4	2.8
82	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.8	2.1	2.4	2.8
83	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.3	1.5	1.8	2.1	2.5	2.8
84	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.3	1.5	1.8	2.2	2.5	2.9
85	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.3	1.6	1.9	2.2	2.5	2.9
86	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.1	1.3	1.6	1.9	2.2	2.6	2.9
87	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.1	1.3	1.6	1.9	2.2	2.6	3.0
88	0.0	0.1	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.3	1.6	1.9	2.3	2.6	3.0
89	0.0	0.1	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.6	1.9	2.3	2.6	3.0
90	0.0	0.1	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.3	2.7	3.1
91	0.0	0.1	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.3	2.7	3.1
92	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.4	2.7	3.1
93	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.4	2.8	3.2
94	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.4	1.7	2.1	2.4	2.8	3.2
95	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.4	1.7	2.1	2.4	2.8	3.2
96	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.9	3.3
97	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.9	3.3
98	0.0	0.1	0.1	0.2	0.4	0.5	0.7	1.0	1.2	1.5	1.8	2.1	2.5	2.9	3.3
99	0.0	0.1	0.1	0.2	0.4	0.5	0.7	1.0	1.2	1.5	1.8	2.2	2.5	2.9	3.4
100	0.0	0.1	0.1	0.2	0.4	0.5	0.7	1.0	1.2	1.5	1.8	2.2	2.6	3.0	3.4
600	0.1	0.4	0.8	1.4	2.3	3.3	4.5	5.8	7.4	9.1	10.0	13.1	15.4	17.8	20.5
700	0.2	0.5	1.0	1.8	2.8	3.9	5.1	6.7	8.7	10.5	12.9	15.3	17.9	20.8	23.9
800	0.2	0.5	1.1	2.0	3.1	4.4	5.9	7.7	9.8	12.1	14.8	17.5	20.6	23.8	27.3
900	0.3	0.7	1.4	2.4	3.6	5.0	6.7	8.7	11.2	13.7	16.7	19.8	23.2	26.8	30.8
	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.04
	Factor														

TO CHANGE DEP. INTO LONG. DIFF. MULTIPLY TABULAR NUMBER BY FACTOR AT FOOT OF COLUMN AND **ADD** PRODUCT TO DEP.

Table 2

To Change Long. Diff. into Dep., **SUBTRACT** Tabular Number from Long. Diff.

Long. Diff. or Dep.	Middle Latitude												
	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°
1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
3	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
4	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
5	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6
6	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
7	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8
8	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9
9	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.1
10	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.2
11	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3
12	0.5	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4
13	0.5	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.5
14	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
15	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.8
16	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9
17	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.4	1.5	1.6	1.7	1.9	2.0
18	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.6	1.7	1.8	2.0	2.1
19	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.6	1.8	1.9	2.1	2.2
20	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.2	2.3
21	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.5
22	0.9	1.0	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.1	2.2	2.4	2.6
23	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	2.0	2.2	2.3	2.5	2.7
24	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.9	2.1	2.2	2.4	2.6	2.8
25	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.3	2.5	2.7	2.9
26	1.0	1.1	1.3	1.4	1.6	1.7	1.9	2.1	2.2	2.4	2.6	2.8	3.0
27	1.0	1.2	1.3	1.5	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.2
28	1.1	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.4	2.6	2.8	3.1	3.3
29	1.1	1.3	1.4	1.6	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.2	3.4
30	1.2	1.3	1.5	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.3	3.5
31	1.2	1.4	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.4	3.6
32	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.2	3.5	3.7
33	1.3	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.9	3.1	3.3	3.6	3.9
34	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.2	3.4	3.7	4.0
35	1.4	1.5	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.3	3.5	3.8	4.1
36	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.9	4.2
37	1.4	1.6	1.8	2.0	2.2	2.5	2.7	2.9	3.2	3.5	3.7	4.0	4.3
38	1.5	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.3	3.6	3.8	4.1	4.4
39	1.5	1.7	1.9	2.1	2.4	2.6	2.8	3.1	3.4	3.7	3.9	4.3	4.6
40	1.5	1.7	2.0	2.2	2.4	2.7	2.9	3.2	3.5	3.7	4.0	4.4	4.7
41	1.6	1.8	2.0	2.2	2.5	2.7	3.0	3.3	3.5	3.8	4.1	4.5	4.8
42	1.6	1.8	2.1	2.3	2.5	2.8	3.1	3.3	3.6	3.9	4.3	4.6	4.9
43	1.7	1.9	2.1	2.3	2.6	2.9	3.1	3.4	3.7	4.0	4.4	4.7	5.0
44	1.7	1.9	2.2	2.4	2.7	2.9	3.2	3.5	3.8	4.1	4.5	4.8	5.2
45	1.7	2.0	2.2	2.5	2.7	3.0	3.3	3.6	3.9	4.2	4.6	4.9	5.3
46	1.8	2.0	2.3	2.5	2.8	3.1	3.3	3.7	4.0	4.3	4.7	5.0	5.4
47	1.8	2.1	2.3	2.6	2.8	3.1	3.4	3.7	4.1	4.4	4.8	5.1	5.5
48	1.9	2.1	2.3	2.6	2.9	3.2	3.5	3.8	4.1	4.5	4.9	5.2	5.6
49	1.9	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.6	5.0	5.3	5.7
50	1.9	2.2	2.4	2.7	3.0	3.3	3.6	4.0	4.3	4.7	5.1	5.4	5.9
100	3.9	4.4	4.9	5.4	6.0	6.6	7.3	7.9	8.6	9.4	10.1	10.9	11.7
200	7.7	8.7	9.8	10.9	12.1	13.3	14.6	15.9	17.3	18.7	20.2	21.8	23.4
300	11.6	13.1	14.7	16.3	18.1	19.9	21.8	23.8	25.9	28.1	30.4	32.7	35.1
400	15.5	17.5	19.6	21.8	24.1	26.6	29.1	31.8	34.6	37.5	40.5	43.6	46.9
500	19.4	21.9	24.5	27.2	30.1	33.2	36.4	39.8	43.2	46.9	50.6	54.5	58.5
Factor	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13

To Change Dep. into Long. Diff., Multiply Tabular Number by Factor at Foot of Column and **ADD** Product to Dep.

TO CHANGE LONG. DIFF. INTO DEP. **SUBTRACT** TABULAR NUMBER FROM LONG. DIFF.

Long Diff. or Dep	Middle Latitude												
	16°	**17°**	**18°**	**19°**	**20°**	**21°**	**22°**	**23°**	**24°**	**25°**	**26°**	**27°**	**28°**
51	2.0	2.2	2.5	2.8	3.1	3.4	3.7	4.1	4.4	4.8	5.2	5.6	6.0
52	2.0	2.3	2.5	2.8	3.1	3.5	3.8	4.1	4.5	4.9	5.3	5.7	6.1
53	2.1	2.3	2.6	2.9	3.2	3.5	3.9	4.2	4.6	5.0	5.4	5.8	6.2
54	2.1	2.4	2.6	2.9	3.3	3.6	3.9	4.3	4.7	5.1	5.5	5.9	6.3
55	2.1	2.4	2.7	3.0	3.3	3.7	4.0	4.4	4.8	5.2	5.6	6.0	6.4
56	2.2	2.4	2.7	3.1	3.4	3.7	4.1	4.5	4.8	5.2	5.7	6.1	6.6
57	2.2	2.5	2.8	3.1	3.4	3.8	4.2	4.5	4.9	5.3	5.8	6.2	6.7
58	2.2	2.5	2.8	3.2	3.5	3.9	4.2	4.6	5.0	5.4	5.9	6.3	6.8
59	2.3	2.6	2.9	3.2	3.6	3.9	4.3	4.7	5.1	5.5	6.0	6.4	6.9
60	2.3	2.6	2.9	3.3	3.6	4.0	4.4	4.8	5.2	5.6	6.1	6.5	7.0
61	2.4	2.7	3.0	3.3	3.7	4.1	4.4	4.8	5.3	5.7	6.2	6.6	7.1
62	2.4	2.7	3.0	3.4	3.7	4.1	4.5	4.9	5.4	5.8	6.3	6.8	7.3
63	2.4	2.8	3.1	3.4	3.8	4.2	4.6	5.0	5.4	5.9	6.4	6.9	7.4
64	2.5	2.8	3.1	3.5	3.9	4.3	4.7	5.1	5.5	6.0	6.5	7.0	7.5
65	2.5	2.8	3.2	3.5	3.9	4.3	4.7	5.2	5.6	6.1	6.6	7.1	7.6
66	2.6	2.9	3.2	3.6	4.0	4.4	4.8	5.2	5.7	6.2	6.7	7.2	7.7
67	2.6	2.9	3.3	3.7	4.0	4.5	4.9	5.3	5.8	6.3	6.8	7.3	7.8
68	2.6	3.0	3.3	3.7	4.1	4.5	5.0	5.4	5.9	6.4	6.9	7.4	8.0
69	2.7	3.0	3.4	3.8	4.2	4.6	5.0	5.5	6.0	6.5	7.0	7.5	8.1
70	2.7	3.1	3.4	3.8	4.2	4.6	5.1	5.6	6.1	6.6	7.1	7.6	8.2
71	2.8	3.1	3.5	3.9	4.3	4.7	5.2	5.6	6.1	6.7	7.2	7.7	8.3
72	2.8	3.1	3.5	3.9	4.3	4.8	5.2	5.7	6.2	6.7	7.3	7.8	8.4
73	2.8	3.2	3.6	4.0	4.4	4.8	5.3	5.8	6.3	6.8	7.4	8.0	8.5
74	2.9	3.2	3.6	4.0	4.5	4.9	5.4	5.9	6.4	6.9	7.5	8.1	8.7
75	2.9	3.3	3.7	4.1	4.5	5.0	5.5	6.0	6.5	7.0	7.6	8.2	8.8
76	2.9	3.3	3.7	4.1	4.6	5.0	5.5	6.0	6.6	7.1	7.7	8.3	8.9
77	3.0	3.4	3.8	4.2	4.6	5.1	5.6	6.1	6.7	7.2	7.8	8.4	9.0
78	3.0	3.4	3.8	4.2	4.7	5.2	5.7	6.2	6.7	7.3	7.9	8.5	9.1
79	3.1	3.5	3.9	4.3	4.8	5.2	5.8	6.3	6.8	7.4	8.0	8.6	9.2
80	3.1	3.5	3.9	4.4	4.8	5.3	5.8	6.4	6.9	7.5	8.1	8.7	9.4
81	3.1	3.5	4.0	4.4	4.9	5.4	5.9	6.4	7.0	7.6	8.2	8.8	9.5
82	3.2	3.6	4.0	4.5	4.9	5.4	6.0	6.5	7.1	7.7	8.3	8.9	9.6
83	3.2	3.6	4.1	4.5	5.0	5.5	6.0	6.6	7.2	7.8	8.4	9.0	9.7
84	3.3	3.7	4.1	4.6	5.1	5.6	6.1	6.7	7.3	7.9	8.5	9.2	9.8
85	3.3	3.7	4.2	4.6	5.1	5.6	6.2	6.8	7.3	8.0	8.6	9.3	9.9
86	3.3	3.8	4.2	4.7	5.2	5.7	6.3	6.8	7.4	8.1	8.7	9.4	10.1
87	3.4	3.8	4.3	4.7	5.2	5.8	6.3	6.9	7.5	8.2	8.8	9.5	10.2
88	3.4	3.8	4.3	4.8	5.3	5.8	6.4	7.0	7.6	8.2	8.9	9.6	10.3
89	3.4	3.9	4.4	4.8	5.4	5.9	6.5	7.1	7.7	8.3	9.0	9.7	10.4
90	3.5	3.9	4.4	4.9	5.4	6.0	6.6	7.2	7.8	8.4	9.1	9.8	10.5
91	3.5	4.0	4.5	5.0	5.5	6.0	6.6	7.2	7.9	8.5	9.2	9.9	10.7
92	3.6	4.0	4.5	5.0	5.5	6.1	6.7	7.3	8.0	8.6	9.3	10.0	10.8
93	3.6	4.1	4.6	5.1	5.6	6.2	6.8	7.4	8.0	8.7	9.4	10.1	10.9
94	3.6	4.1	4.6	5.1	5.7	6.2	6.8	7.5	8.1	8.8	9.5	10.2	11.0
95	3.7	4.2	4.6	5.2	5.7	6.3	6.9	7.6	8.2	8.9	9.6	10.4	11.1
96	3.7	4.2	4.7	5.2	5.8	6.4	7.0	7.6	8.3	9.0	9.7	10.5	11.2
97	3.8	4.2	4.7	5.3	5.8	6.4	7.1	7.7	8.4	9.1	9.8	10.6	11.4
98	3.8	4.3	4.8	5.3	5.9	6.5	7.1	7.8	8.5	9.2	9.9	10.7	11.5
99	3.8	4.3	4.8	5.4	6.0	6.6	7.2	7.9	8.6	9.3	10.0	10.8	11.6
100	3.9	4.4	4.9	5.4	6.0	6.6	7.3	7.9	8.6	9.4	10.1	10.9	11.7
600	23.2	26.2	29.4	32.7	36.2	39.9	43.7	47.7	51.9	56.2	60.7	65.4	70.2
700	27.2	30.6	34.2	38.1	42.1	46.4	50.9	55.7	60.5	65.5	70.8	76.3	82.0
800	31.0	35.0	39.2	43.5	48.2	53.1	58.2	63.6	69.2	74.9	80.9	87.1	93.7
900	35.0	39.4	44.1	49.1	54.3	59.7	65.5	71.7	77.9	84.4	91.1	98.1	105.5
Factor	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13

TO CHANGE DEP. INTO LONG. DIFF. MULTIPLY TABULAR NUMBER BY FACTOR AT FOOT OF COLUMN, AND **ADD** PRODUCT TO DEP.

TO CHANGE LONG. DIFF. INTO DEP., **SUBTRACT** TABULAR NUMBER FROM LONG. DIFF.

Long. Diff. or Dep.	Middle Latitude											
	29°	**30°**	**31°**	**32°**	**33°**	**34°**	**35°**	**36°**	**37°**	**38°**	**39°**	**40°**
1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5
3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7
4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9
5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2
6	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4
7	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6
8	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9
9	1.1	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.0	2.1
10	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3
11	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	2.6
12	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.7	2.8
13	1.6	1.7	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3.0
14	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.7	2.8	3.0	3.1	3.3
15	1.9	2.0	2.1	2.3	2.4	2.6	2.7	2.9	3.0	3.2	3.3	3.5
16	2.0	2.1	2.3	2.4	2.6	2.7	2.9	3.1	3.2	3.4	3.6	3.7
17	2.1	2.3	2.4	2.6	2.7	2.9	3.1	3.2	3.4	3.6	3.8	4.0
18	2.3	2.4	2.6	2.7	2.9	3.1	3.3	3.4	3.6	3.8	4.0	4.2
19	2.4	2.5	2.7	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4
20	2.5	2.7	2.9	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.5	4.7
21	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.5	4.7	4.9
22	2.8	2.9	3.1	3.3	3.5	3.8	4.0	4.2	4.4	4.7	4.9	5.1
23	2.9	3.1	3.3	3.5	3.7	3.9	4.2	4.4	4.6	4.9	5.1	5.4
24	3.0	3.2	3.4	3.6	3.9	4.1	4.3	4.6	4.8	5.1	5.3	5.6
25	3.1	3.3	3.6	3.8	4.0	4.3	4.5	4.8	5.0	5.3	5.6	5.8
26	3.3	3.5	3.7	4.0	4.2	4.4	4.7	5.0	5.2	5.5	5.8	6.1
27	3.4	3.6	3.9	4.1	4.4	4.6	4.9	5.2	5.4	5.7	6.0	6.3
28	3.5	3.8	4.0	4.3	4.5	4.8	5.1	5.3	5.6	5.9	6.2	6.6
29	3.6	3.9	4.1	4.4	4.7	5.0	5.2	5.5	5.8	6.1	6.5	6.8
30	3.8	4.0	4.3	4.6	4.8	5.1	5.4	5.7	6.0	6.4	6.7	7.0
31	3.9	4.2	4.4	4.7	5.0	5.3	5.6	5.9	6.2	6.6	6.9	7.3
32	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.8	7.1	7.5
33	4.1	4.4	4.7	5.0	5.3	5.6	6.0	6.3	6.6	7.0	7.4	7.7
34	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.5	6.8	7.2	7.6	8.0
35	4.4	4.7	5.0	5.3	5.6	6.0	6.3	6.7	7.0	7.4	7.8	8.2
36	4.5	4.8	5.1	5.5	5.8	6.2	6.5	6.9	7.2	7.6	8.0	8.4
37	4.6	5.0	5.3	5.6	6.0	6.3	6.7	7.1	7.5	7.8	8.2	8.7
38	4.8	5.1	5.4	5.8	6.1	6.5	6.9	7.3	7.7	8.1	8.5	8.9
39	4.9	5.2	5.6	5.9	6.3	6.7	7.1	7.4	7.9	8.3	8.7	9.1
40	5.0	5.4	5.7	6.1	6.5	6.8	7.2	7.6	8.1	8.5	8.9	9.4
41	5.1	5.5	5.9	6.2	6.6	7.0	7.4	7.8	8.3	8.7	9.1	9.6
42	5.3	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.5	8.9	9.4	9.8
43	5.4	5.8	6.1	6.5	6.9	7.4	7.8	8.2	8.7	9.1	9.6	10.1
44	5.5	5.9	6.3	6.7	7.1	7.5	8.0	8.4	8.9	9.3	9.8	10.3
45	5.6	6.0	6.4	6.8	7.3	7.7	8.1	8.6	9.1	9.5	10.0	10.5
46	5.8	6.2	6.6	7.0	7.4	7.9	8.3	8.8	9.3	9.8	10.3	10.8
47	5.9	6.3	6.7	7.1	7.6	8.0	8.5	9.0	9.5	10.0	10.5	11.0
48	6.0	6.4	6.9	7.3	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2
49	6.1	6.6	7.0	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.5
50	6.3	6.7	7.1	7.6	8.1	8.5	9.0	9.5	10.1	10.6	11.1	11.7
100	12.5	13.4	14.3	15.2	16.1	17.1	18.1	19.1	20.1	21.2	22.3	23.4
200	25.1	26.8	28.6	30.4	32.3	34.2	36.2	38.2	40.3	42.4	44.6	46.8
300	37.6	40.2	42.9	45.6	48.4	51.3	54.3	57.3	60.4	63.6	66.9	70.2
400	50.2	53.6	57.1	60.8	64.5	68.4	72.3	76.4	80.6	84.8	89.1	93.6
500	62.7	67.0	71.4	76.0	80.7	85.5	90.4	95.5	100.7	106.0	111.4	117.0
	1.14	1.15	1.17	1.18	1.19	1.21	1.22	1.24	1.25	1.27	1.29	1.31
	Factor											

TO CHANGE DEP. INTO LONG. DIFF., MULTIPLY TABULAR NUMBER BY FACTOR AT FOOT OF COLUMN, AND **ADD** PRODUCT TO DEP.

To Change Long. Diff. into Dep. **subtract** Tabular Number from Long. Diff.

Long. Diff. or Dep.	Middle Latitude											
	29°	**30°**	**31°**	**32°**	**33°**	**34°**	**35°**	**36°**	**37°**	**38°**	**39°**	**40°**
51	6.4	6.8	7.3	7.7	8.2	8.7	9.2	9.7	10.3	10.8	11.4	11.9
52	6.5	7.0	7.4	7.9	8.4	8.9	9.4	9.9	10.5	11.0	11.6	12.2
53	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.7	11.2	11.8	12.4
54	6.8	7.2	7.7	8.2	8.7	9.2	9.8	10.3	10.9	11.4	12.0	12.6
55	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.5	11.1	11.7	12.3	12.9
56	7.0	7.5	8.0	8.5	9.0	9.6	10.1	10.7	11.3	11.9	12.5	13.1
57	7.1	7.6	8.1	8.7	9.2	9.7	10.3	10.9	11.5	12.1	12.7	13.3
58	7.3	7.8	8.3	8.8	9.4	9.9	10.5	11.1	11.7	12.3	12.9	13.6
59	7.4	7.9	8.4	9.0	9.5	10.1	10.7	11.3	11.9	12.5	13.1	13.8
60	7.5	8.0	8.6	9.1	9.7	10.3	10.9	11.5	12.1	12.7	13.4	14.0
61	7.6	8.2	8.7	9.3	9.8	10.4	11.0	11.6	12.3	12.9	13.6	14.3
62	7.8	8.3	8.9	9.4	10.0	10.6	11.2	11.8	12.5	13.1	13.8	14.5
63	7.9	8.4	9.0	9.6	10.2	10.8	11.4	12.0	12.7	13.4	14.0	14.7
64	8.0	8.6	9.1	9.7	10.3	10.9	11.6	12.2	12.9	13.6	14.3	15.0
65	8.1	8.7	9.3	9.9	10.5	11.1	11.8	12.4	13.1	13.8	14.5	15.2
66	8.3	8.8	9.4	10.0	10.6	11.3	11.9	12.6	13.3	14.0	14.7	15.4
67	8.4	9.0	9.6	10.2	10.8	11.5	12.1	12.8	13.5	14.2	14.9	15.7
68	8.5	9.1	9.7	10.3	11.0	11.6	12.3	13.0	13.7	14.4	15.2	15.9
69	8.7	9.2	9.9	10.5	11.1	11.8	12.5	13.2	13.9	14.6	15.4	16.1
70	8.8	9.4	10.0	10.6	11.3	12.0	12.7	13.4	14.1	14.8	15.6	16.4
71	8.9	9.5	10.1	10.8	11.5	12.1	12.8	13.6	14.3	15.1	15.8	16.6
72	9.0	9.6	10.3	10.9	11.6	12.3	13.0	13.8	14.5	15.3	16.0	16.8
73	9.2	9.8	10.4	11.1	11.8	12.5	13.2	13.9	14.7	15.5	16.3	17.1
74	9.3	9.9	10.6	11.2	11.9	12.7	13.4	14.1	14.9	15.7	16.5	17.3
75	9.4	10.0	10.7	11.4	12.1	12.8	13.6	14.3	15.1	15.9	16.7	17.5
76	9.5	10.2	10.9	11.5	12.3	13.0	13.7	14.5	15.3	16.1	16.9	17.8
77	9.7	10.3	11.0	11.7	12.4	13.2	13.9	14.7	15.5	16.3	17.2	18.0
78	9.8	10.5	11.1	11.9	12.6	13.3	14.1	14.9	15.7	16.5	17.4	18.2
79	9.9	10.6	11.3	12.0	12.7	13.5	14.3	15.1	15.9	16.7	17.6	18.5
80	10.0	10.7	11.4	12.2	12.9	13.7	14.5	15.3	16.1	17.0	17.8	18.7
81	10.2	10.9	11.6	12.3	13.1	13.8	14.6	15.5	16.3	17.2	18.1	19.0
82	10.3	11.0	11.7	12.5	13.2	14.0	14.8	15.7	16.5	17.4	18.3	19.2
83	10.4	11.1	11.9	12.6	13.4	14.2	15.0	15.9	16.7	17.6	18.5	19.4
84	10.5	11.3	12.0	12.8	13.6	14.4	15.2	16.0	16.9	17.8	18.7	19.7
85	10.7	11.4	12.1	12.9	13.7	14.5	15.4	16.2	17.1	18.0	18.9	19.9
86	10.8	11.5	12.3	13.1	13.9	14.7	15.6	16.4	17.3	18.2	19.2	20.1
87	10.9	11.7	12.4	13.2	14.0	14.9	15.7	16.6	17.5	18.4	19.4	20.4
88	11.0	11.8	12.6	13.4	14.2	15.0	15.9	16.8	17.7	18.7	19.6	20.6
89	11.2	11.9	12.7	13.5	14.4	15.2	16.1	17.0	17.9	18.9	19.8	20.8
90	11.3	12.1	12.9	13.7	14.5	15.4	16.3	17.2	18.1	19.1	20.1	21.1
91	11.4	12.2	13.0	13.8	14.7	15.6	16.5	17.4	18.3	19.3	20.3	21.3
92	11.5	12.3	13.1	14.0	14.8	15.7	16.6	17.6	18.5	19.5	20.5	21.5
93	11.7	12.5	13.3	14.1	15.0	15.9	16.8	17.8	18.7	19.7	20.7	21.8
94	11.8	12.6	13.4	14.3	15.2	16.1	17.0	18.0	18.9	19.9	20.9	22.0
95	11.9	12.7	13.6	14.4	15.3	16.2	17.2	18.1	19.1	20.1	21.2	22.2
96	12.0	12.9	13.7	14.6	15.5	16.4	17.4	18.3	19.3	20.4	21.4	22.5
97	12.2	13.0	13.9	14.7	15.6	16.6	17.5	18.5	19.5	20.6	21.6	22.7
98	12.3	13.1	14.0	14.9	15.8	16.8	17.7	18.7	19.7	20.8	21.8	22.9
99	12.4	13.3	14.1	15.0	16.0	16.9	17.9	18.9	19.9	21.0	22.1	23.2
100	12.5	13.4	14.3	15.2	16.1	17.1	18.1	19.1	20.1	21.2	22.3	23.4
600	75.2	80.4	85.7	91.2	96.8	102.6	108.5	114.6	120.8	127.2	133.7	140.4
700	87.8	93.9	99.9	106.4	113.0	119.7	126.5	133.8	141.0	148.4	156.1	163.7
800	100.3	107.2	114.2	121.6	129.0	136.7	144.6	152.7	161.1	169.6	178.2	187.0
900	113.0	120.7	128.6	136.8	145.2	153.9	162.8	171.9	181.4	190.9	200.7	210.5
	1.14	1.15	1.17	1.18	1.19	1.21	1.22	1.24	1.25	1.27	1.29	1.31
	Factor											

To Change Dep. into Long. Diff. Multiply Tabular Number by Factor at Foot of Column and **add** Product to Dep.

To Change Long. Diff. into Dep., **subtract** Tabular Number from Long. Diff.

Long. Diff. or Dep.	Middle Latitude 41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°
1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
2	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
3	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.1
4	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5
5	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.9
6	1.5	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.1	2.2
7	1.7	1.8	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.6
8	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.0
9	2.2	2.3	2.4	2.5	2.6	2.7	2.9	3.0	3.1	3.2	3.3
10	2.5	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.4	3.6	3.7
11	2.7	2.8	3.0	3.1	3.2	3.4	3.5	3.6	3.8	3.9	4.1
12	2.9	3.1	3.2	3.4	3.5	3.7	3.8	4.0	4.1	4.3	4.4
13	3.2	3.3	3.5	3.6	3.8	4.0	4.1	4.3	4.5	4.6	4.8
14	3.4	3.6	3.8	3.9	4.1	4.3	4.5	4.6	4.8	5.0	5.2
15	3.7	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6
16	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9
17	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.1	6.3
18	4.4	4.6	4.8	5.1	5.3	5.5	5.7	6.0	6.2	6.4	6.7
19	4.7	4.9	5.1	5.3	5.6	5.8	6.0	6.3	6.5	6.8	7.0
20	4.9	5.1	5.4	5.6	5.9	6.1	6.4	6.6	6.9	7.1	7.4
21	5.2	5.4	5.6	5.9	6.2	6.4	6.7	6.9	7.2	7.5	7.8
22	5.4	5.7	5.9	6.2	6.4	6.7	7.0	7.3	7.6	7.9	8.2
23	5.6	5.9	6.2	6.5	6.7	7.0	7.3	7.6	7.9	8.2	8.5
24	5.9	6.2	6.4	6.7	7.0	7.3	7.6	7.9	8.3	8.6	8.9
25	6.1	6.4	6.7	7.0	7.3	7.6	8.0	8.3	8.6	8.9	9.3
26	6.4	6.7	7.0	7.3	7.6	7.9	8.3	8.6	8.9	9.3	9.6
27	6.6	6.9	7.3	7.6	7.9	8.2	8.6	8.9	9.3	9.6	10.0
28	6.9	7.2	7.5	7.9	8.2	8.5	8.9	9.3	9.6	10.0	10.4
29	7.1	7.4	7.8	8.1	8.5	8.9	9.2	9.6	10.0	10.4	10.7
30	7.4	7.7	8.1	8.4	8.8	9.2	9.5	9.9	10.3	10.7	11.1
31	7.6	8.0	8.3	8.7	9.1	9.5	9.9	10.3	10.7	11.1	11.5
32	7.8	8.2	8.6	9.0	9.4	9.8	10.2	10.6	11.0	11.4	11.9
33	8.1	8.5	8.9	9.3	9.7	10.1	10.5	10.9	11.4	11.8	12.2
34	8.3	8.7	9.1	9.5	10.0	10.4	10.8	11.2	11.7	12.1	12.6
35	8.6	9.0	9.4	9.8	10.3	10.7	11.1	11.6	12.0	12.5	13.0
36	8.8	9.2	9.7	10.1	10.5	11.0	11.4	11.9	12.4	12.9	13.3
37	9.1	9.5	9.9	10.4	10.8	11.3	11.8	12.2	12.7	13.2	13.7
38	9.3	9.8	10.2	10.7	11.1	11.6	12.1	12.6	13.1	13.6	14.1
39	9.6	10.0	10.5	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.5
40	9.8	10.3	10.7	11.2	11.7	12.2	12.7	13.2	13.8	14.3	14.8
41	10.1	10.5	11.0	11.5	12.0	12.5	13.0	13.6	14.1	14.6	15.2
42	10.3	10.8	11.3	11.8	12.3	12.8	13.4	13.9	14.4	15.0	15.6
43	10.5	11.0	11.6	12.1	12.6	13.1	13.7	14.2	14.8	15.4	15.9
44	10.8	11.3	11.8	12.3	12.9	13.4	14.0	14.6	15.1	15.7	16.3
45	11.0	11.6	12.1	12.6	13.2	13.7	14.3	14.9	15.5	16.1	16.7
46	11.3	11.8	12.4	12.9	13.5	14.0	14.6	15.2	15.8	16.4	17.1
47	11.5	12.1	12.6	13.2	13.8	14.4	14.9	15.6	16.2	16.8	17.4
48	11.8	12.3	12.9	13.5	14.1	14.7	15.3	15.9	16.5	17.1	17.8
49	12.0	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.9	17.5	18.2
50	12.3	12.8	13.4	14.0	14.6	15.3	15.9	16.5	17.2	17.9	18.5
100	24.5	25.7	26.9	28.1	29.3	30.5	31.8	33.1	34.4	35.7	37.1
200	49.1	51.4	53.7	56.1	58.6	61.1	63.6	66.2	68.8	71.4	74.1
300	73.6	77.1	80.6	84.2	87.9	91.6	95.4	99.3	103.2	107.2	111.2
400	98.1	102.7	107.4	112.3	117.2	122.1	127.2	132.3	137.6	142.9	148.3
500	122.7	128.4	134.3	140.3	146.5	152.7	159.0	165.4	172.0	178.6	185.3
Factor	1.33	1.35	1.37	1.39	1.41	1.44	1.47	1.50	1.52	1.56	1.59

To Change Dep. into Long. Diff., Multiply Tabular Number by Factor at Foot of Column, and **add** Product to Dep.

Table 2

To Change Long. Diff. into Dep. **SUBTRACT** Tabular Number from Long. Diff.

Long. Diff. or Dep.	Middle Latitude 41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°
51	12.5	13.1	13.7	14.3	14.9	15.6	16.2	16.9	17.5	18.2	18.9
52	12.8	13.4	14.0	14.6	15.2	15.9	16.5	17.2	17.9	18.6	19.3
53	13.0	13.6	14.2	14.9	15.5	16.2	16.9	17.5	18.2	18.9	19.6
54	13.2	13.9	14.5	15.2	15.8	16.5	17.2	17.9	18.6	19.3	20.0
55	13.5	14.1	14.8	15.4	16.1	16.8	17.5	18.2	18.9	19.6	20.4
56	13.7	14.4	15.0	15.7	16.4	17.1	17.8	18.5	19.3	20.0	20.8
57	14.0	14.6	15.3	16.0	16.7	17.4	18.1	18.9	19.6	20.4	21.1
58	14.2	14.9	15.6	16.3	17.0	17.7	18.4	19.2	19.9	20.7	21.5
59	14.5	15.2	15.9	16.6	17.3	18.0	18.8	19.5	20.3	21.1	21.9
60	14.7	15.4	16.1	16.8	17.6	18.3	19.1	19.9	20.6	21.4	22.2
61	15.0	15.7	16.4	17.1	17.9	18.6	19.4	20.2	21.0	21.8	22.6
62	15.2	15.9	16.7	17.4	18.2	18.9	19.7	20.5	21.3	22.1	23.0
63	15.5	16.2	16.9	17.7	18.5	19.2	20.0	20.8	21.7	22.5	23.4
64	15.7	16.4	17.2	18.0	18.7	19.5	20.4	21.2	22.0	22.9	23.7
65	15.9	16.7	17.5	18.2	19.0	19.8	20.7	21.5	22.4	23.2	24.1
66	16.2	17.0	17.7	18.5	19.3	20.2	21.0	21.8	22.7	23.6	24.5
67	16.4	17.2	18.0	18.8	19.6	20.5	21.3	22.2	23.0	23.9	24.8
68	16.7	17.5	18.3	19.1	19.9	20.8	21.6	22.5	23.4	24.3	25.2
69	16.9	17.7	18.5	19.4	20.2	21.1	21.9	22.8	23.7	24.6	25.6
70	17.2	18.0	18.8	19.6	20.5	21.4	22.3	23.2	24.1	25.0	25.9
71	17.4	18.2	19.1	19.9	20.8	21.7	22.6	23.5	24.4	25.4	26.3
72	17.7	18.5	19.3	20.2	21.1	22.0	22.9	23.8	24.8	25.7	26.7
73	17.9	18.8	19.6	20.5	21.4	22.3	23.2	24.2	25.1	26.1	27.1
74	18.2	19.0	19.9	20.8	21.7	22.6	23.5	24.5	25.5	26.4	27.4
75	18.4	19.3	20.1	21.0	22.0	22.9	23.9	24.8	25.8	26.8	27.8
76	18.6	19.5	20.4	21.3	22.3	23.2	24.2	25.1	26.1	27.1	28.2
77	18.9	19.8	20.7	21.6	22.6	23.5	24.5	25.5	26.5	27.5	28.5
78	19.1	20.0	21.0	21.9	22.8	23.8	24.8	25.8	26.8	27.9	28.9
79	19.4	20.3	21.2	22.2	23.1	24.1	25.1	26.1	27.2	28.2	29.3
80	19.6	20.5	21.5	22.5	23.4	24.4	25.4	26.5	27.5	28.6	29.7
81	19.9	20.8	21.8	22.7	23.7	24.7	25.8	26.8	27.9	28.9	30.0
82	20.1	21.1	22.0	23.0	24.0	25.0	26.1	27.1	28.2	29.3	30.4
83	20.4	21.3	22.3	23.3	24.3	25.3	26.4	27.5	28.5	29.6	30.8
84	20.6	21.6	22.6	23.6	24.6	25.6	26.7	27.8	28.9	30.0	31.1
85	20.8	21.8	22.8	23.9	24.9	26.0	27.0	28.1	29.2	30.4	31.5
86	21.1	22.1	23.1	24.1	25.2	26.3	27.3	28.5	29.6	30.7	31.9
87	21.3	22.3	23.4	24.4	25.5	26.6	27.7	28.8	29.9	31.1	32.2
88	21.6	22.6	23.6	24.7	25.8	26.9	28.0	29.1	30.3	31.4	32.6
89	21.8	22.9	23.9	25.0	26.1	27.2	28.3	29.4	30.6	31.8	33.0
90	22.1	23.1	24.2	25.3	26.4	27.5	28.6	29.8	31.0	32.1	33.4
91	22.3	23.4	24.4	25.5	26.7	27.8	28.9	30.1	31.3	32.5	33.7
92	22.6	23.6	24.7	25.8	26.9	28.1	29.3	30.4	31.6	32.9	34.1
93	22.8	23.9	25.0	26.1	27.2	28.4	29.6	30.8	32.0	33.2	34.5
94	23.1	24.1	25.3	26.4	27.5	28.7	29.9	31.1	32.3	33.6	34.8
95	23.3	24.4	25.5	26.7	27.8	29.0	30.2	31.4	32.7	33.9	35.2
96	23.5	24.7	25.8	26.9	28.1	29.3	30.5	31.8	33.0	34.3	35.6
97	23.8	24.9	26.1	27.2	28.4	29.6	30.8	32.1	33.4	34.6	36.0
98	24.0	25.2	26.3	27.5	28.7	29.9	31.2	32.4	33.7	35.0	36.3
99	24.3	25.4	26.6	27.8	29.0	30.2	31.5	32.8	34.1	35.4	36.7
100	24.5	25.7	26.9	28.1	29.3	30.5	31.8	33.1	34.4	35.7	37.1
600	147.2	154.1	161.2	168.4	175.7	183.2	190.8	198.5	206.4	214.3	222.4
700	171.7	179.8	188.1	196.5	205.0	213.7	222.6	231.6	240.8	250.0	259.4
800	196.1	205.4	214.9	224.6	234.3	244.2	254.4	264.7	275.2	285.8	296.5
900	220.8	231.2	241.8	252.7	263.7	274.8	286.2	297.8	309.7	321.5	333.7
Factor	1.33	1.35	1.37	1.39	1.41	1.44	1.47	1.50	1.52	1.56	1.59

To Change Dep. into Long. Diff. Multiply Tabular Number by Factor at Foot of Column and **ADD** Product to Dep.

Table 2

To Change Long. Diff. into Dep., **SUBTRACT** Tabular Number from Long. Diff.

Long. Diff. or Dep.	Middle Latitude								
	52°	**53°**	**54°**	**55°**	**56**	**57°**	**58°**	**59°**	**60°**
1	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
2	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0
3	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5
4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	2.0
5	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.4	2.5
6	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0
7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5
8	3.1	3.2	3.3	3.4	3.5	3.6	3.8	3.9	4.0
9	3.5	3.6	3.7	3.8	4.0	4.1	4.2	4.4	4.5
10	3.8	4.0	4.1	4.3	4.4	4.6	4.7	4.8	5.0
11	4.2	4.4	4.5	4.7	4.8	5.0	5.2	5.3	5.5
12	4.6	4.8	4.9	5.1	5.3	5.5	5.6	5.8	6.0
13	5.0	5.2	5.4	5.5	5.7	5.9	6.1	6.3	6.5
14	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0
15	5.8	6.0	6.2	6.4	6.6	6.8	7.1	7.3	7.5
16	6.1	6.4	6.6	6.8	7.1	7.3	7.5	7.8	8.0
17	6.5	6.8	7.0	7.2	7.5	7.7	8.0	8.2	8.5
18	6.9	7.2	7.4	7.7	7.9	8.2	8.5	8.7	9.0
19	7.3	7.6	7.8	8.1	8.4	8.7	8.9	9.2	9.5
20	7.7	8.0	8.2	8.5	8.8	9.1	9.4	9.7	10.0
21	8.1	8.4	8.7	9.0	9.3	9.6	9.9	10.2	10.5
22	8.5	8.8	9.1	9.4	9.7	10.0	10.3	10.7	11.0
23	8.8	9.2	9.5	9.8	10.1	10.5	10.8	11.2	11.5
24	9.2	9.6	9.9	10.2	10.6	10.9	11.3	11.6	12.0
25	9.6	10.0	10.3	10.7	11.0	11.4	11.8	12.1	12.5
26	10.0	10.4	10.7	11.1	11.5	11.8	12.2	12.6	13.0
27	10.4	10.8	11.1	11.5	11.9	12.3	12.7	13.1	13.5
28	10.8	11.1	11.5	11.9	12.3	12.8	13.2	13.6	14.0
29	11.1	11.5	12.0	12.4	12.8	13.2	13.6	14.1	14.5
30	11.5	11.9	12.4	12.8	13.2	13.7	14.1	14.5	15.0
31	11.9	12.3	12.8	13.2	13.7	14.1	14.6	15.0	15.5
32	12.3	12.7	13.2	13.6	14.1	14.6	15.0	15.5	16.0
33	12.7	13.1	13.6	14.1	14.5	15.0	15.5	16.0	16.5
34	13.1	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0
35	13.5	13.9	14.4	14.9	15.4	15.9	16.5	17.0	17.5
36	13.8	14.3	14.8	15.4	15.9	16.4	16.9	17.5	18.0
37	14.2	14.7	15.3	15.8	16.3	16.8	17.4	17.9	18.5
38	14.6	15.1	15.7	16.2	16.8	17.3	17.9	18.4	19.0
39	15.0	15.5	16.1	16.6	17.2	17.8	18.3	18.9	19.5
40	15.4	15.9	16.5	17.1	17.6	18.2	18.8	19.4	20.0
41	15.8	16.3	16.9	17.5	18.1	18.7	19.3	19.9	20.5
42	16.1	16.7	17.3	17.9	18.5	19.1	19.7	20.4	21.0
43	16.5	17.1	17.7	18.3	19.0	19.6	20.2	20.9	21.5
44	16.9	17.5	18.1	18.8	19.4	20.0	20.7	21.3	22.0
45	17.3	17.9	18.5	19.2	19.8	20.5	21.2	21.8	22.5
46	17.7	18.3	19.0	19.6	20.3	20.9	21.6	22.3	23.0
47	18.1	18.7	19.4	20.0	20.7	21.4	22.1	22.8	23.5
48	18.4	19.1	19.8	20.5	21.2	21.9	22.6	23.3	24.0
49	18.8	19.5	20.2	20.9	21.6	22.3	23.0	23.8	24.5
50	19.2	19.9	20.6	21.3	22.0	22.8	23.5	24.2	25.0
100	38.4	39.8	41.2	42.6	44.1	45.5	47.0	48.5	50.0
200	76.9	79.6	82.4	85.3	88.2	91.1	94.0	97.0	100.0
300	115.3	119.5	123.7	127.9	132.2	136.6	141.0	145.5	150.0
400	153.7	159.3	164.9	170.6	176.3	182.2	188.1	194.0	200.0
500	192.2	199.1	206.1	213.2	220.4	227.7	235.0	242.5	250.0
Factor	1.62	1.66	1.70	1.74	1.79	1.84	1.89	1.94	2.00

To Change Dep. into Long. Diff., Multiply Tabular Number by Factor at Foot of Column and **ADD** Product to Dep.

TO CHANGE LONG. DIFF. INTO DEP. **SUBTRACT** TABULAR NUMBER FROM LONG. DIFF.

Long. Diff. or Dep.	Middle Latitude								
	52°	**53°**	**54°**	**55°**	**56°**	**57°**	**58°**	**59°**	**60°**
51	19.6	20.3	21.0	21.7	22.5	23.2	24.0	24.7	25.5
52	20.0	20.7	21.4	22.2	22.9	23.7	24.4	25.2	26.0
53	20.4	21.1	21.8	22.6	23.4	24.1	24.9	25.7	26.5
54	20.8	21.5	22.3	23.0	23.8	24.6	25.4	26.2	27.0
55	21.1	21.9	22.7	23.5	24.2	25.0	25.9	26.7	27.5
56	21.5	22.3	23.1	23.9	24.7	25.5	26.3	27.2	28.0
57	21.9	22.7	23.5	24.3	25.1	26.0	26.8	27.6	28.5
58	22.3	23.1	23.9	24.7	25.6	26.4	27.3	28.1	29.0
59	22.7	23.5	24.3	25.2	26.0	26.9	27.7	28.6	29.5
60	23.1	23.9	24.7	25.6	26.4	27.3	28.2	29.1	30.0
61	23.4	24.3	25.1	26.0	26.9	27.8	28.7	29.6	30.5
62	23.8	24.7	25.6	26.4	27.3	28.2	29.1	30.1	31.0
63	24.2	25.1	26.0	26.9	27.8	28.7	29.6	30.6	31.5
64	24.6	25.5	26.4	27.3	28.2	29.1	30.1	31.0	32.0
65	25.0	25.9	26.8	27.7	28.7	29.6	30.6	31.5	32.5
66	25.4	26.3	27.2	28.1	29.1	30.1	31.0	32.0	33.0
67	25.8	26.7	27.6	28.6	29.5	30.5	31.5	32.5	33.5
68	26.1	27.1	28.0	29.0	30.0	31.0	32.0	33.0	34.0
69	26.5	27.5	28.4	29.4	30.4	31.4	32.4	33.5	34.5
70	26.9	27.9	28.9	29.8	30.9	31.9	32.9	33.9	35.0
71	27.3	28.3	29.3	30.3	31.3	32.3	33.4	34.4	35.5
72	27.7	28.7	29.7	30.7	31.7	32.8	33.8	34.9	36.0
73	28.1	29.1	30.1	31.1	32.2	33.2	34.3	35.4	36.5
74	28.4	29.5	30.5	31.6	32.6	33.7	34.8	35.9	37.0
75	28.8	29.9	30.9	32.0	33.1	34.2	35.3	36.4	37.5
76	29.2	30.3	31.3	32.4	33.5	34.6	35.7	36.9	38.0
77	29.6	30.7	31.7	32.8	33.9	35.1	36.2	37.3	38.5
78	30.0	31.1	32.2	33.3	34.4	35.5	36.7	37.8	39.0
79	30.4	31.5	32.6	33.7	34.8	36.0	37.1	38.3	39.5
80	30.7	31.9	33.0	34.1	35.3	36.4	37.6	38.8	40.0
81	31.1	32.3	33.4	34.5	35.7	36.9	38.1	39.3	40.5
82	31.5	32.7	33.8	35.0	36.1	37.3	38.5	39.8	41.0
83	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.3	41.5
84	32.3	33.4	34.6	35.8	37.0	38.3	39.5	40.7	42.0
85	32.7	33.8	35.0	36.2	37.5	38.7	40.0	41.2	42.5
86	33.1	34.2	35.5	36.7	37.9	39.2	40.4	41.7	43.0
87	33.4	34.6	35.9	37.1	38.4	39.6	40.9	42.2	43.5
88	33.8	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0
89	34.2	35.4	36.7	38.0	39.2	40.5	41.8	43.2	44.5
90	34.6	35.8	37.1	38.4	39.7	41.0	42.3	43.6	45.0
91	35.0	36.2	37.5	38.8	40.1	41.4	42.8	44.1	45.5
92	35.4	36.6	37.9	39.2	40.6	41.9	43.2	44.6	46.0
93	35.7	37.0	38.3	39.7	41.0	42.3	43.7	45.1	46.5
94	36.1	37.4	38.7	40.1	41.4	42.8	44.2	45.6	47.0
95	36.5	37.8	39.2	40.5	41.9	43.3	44.7	46.1	47.5
96	36.9	38.2	39.6	40.9	42.3	43.7	45.1	46.6	48.0
97	37.3	38.6	40.0	41.4	42.8	44.2	45.6	47.0	48.5
98	37.7	39.0	40.4	41.8	43.2	44.6	46.1	47.5	49.0
99	38.0	39.4	40.8	42.2	43.6	45.1	46.5	48.0	49.5
100	38.4	39.8	41.2	42.6	44.1	45.5	47.0	48.5	50.0
600	230.6	238.9	247.3	255.9	264.5	273.2	282.0	291.0	300.0
700	269.2	279.7	288.6	298.5	308.6	318.7	329.0	339.6	350.0
800	307.5	319.5	329.8	341.2	352.6	364.3	376.1	388.0	400.0
900	346.0	358.3	371.1	383.8	396.8	409.9	423.2	436.6	450.0
	1.63	1.66	1.70	1.74	1.79	1.84	1.89	1.94	2.00
	Factor								

TO CHANGE DEP. INTO LONG. DIFF. MULTIPLY TABULAR NUMBER BY FACTOR AT FOOT OF COLUMN AND **ADD** PRODUCT TO DEP.

	0	1	2	3	4	5	6	7	8	9
100	00000	043	087	130	173	217	260	303	346	389
01	432	475	518	561	604	647	689	732	775	817
02	860	903	945	988	*030	*072	*115	*157	*199	*242
03	01284	326	368	410	452	494	536	578	620	662
04	703	745	787	828	870	912	953	995	*036	*078
05	02119	160	202	243	284	325	366	407	449	490
06	531	572	612	653	694	735	776	816	857	898
07	938	979	*019	*060	*100	*141	*181	*222	*262	*302
08	03342	383	423	463	503	543	583	623	663	703
09	743	782	822	862	902	941	981	*021	*060	*100
110	04139	179	218	258	297	336	376	415	454	493
11	532	571	610	650	689	727	766	805	844	883
12	922	961	999	*038	*077	*115	*154	*192	*231	*269
13	05308	346	385	423	461	500	538	576	614	652
14	690	729	767	805	843	881	918	956	994	*032
15	06070	108	145	183	221	258	296	333	371	408
16	446	483	521	558	595	633	670	707	744	781
17	819	856	893	930	967	*004	*041	*078	*115	*151
18	07188	225	262	298	335	372	408	445	482	518
19	555	591	628	664	700	737	773	809	846	882
120	918	954	990	*027	*063	*099	*135	*171	*207	*243
21	08279	314	350	386	422	458	493	529	565	600
22	636	672	707	743	778	814	849	884	920	955
23	991	*026	*061	*096	*132	*167	*202	*237	*272	*307
24	09342	377	412	447	482	517	552	587	621	656
25	691	726	760	795	830	864	899	934	968	*003
26	10037	072	106	140	175	209	243	278	312	346
27	380	415	449	483	517	551	585	619	653	687
28	721	755	789	823	857	890	924	958	992	*025
29	11059	093	126	160	193	227	261	294	327	361
130	394	428	461	494	528	561	594	628	661	694
31	727	760	793	826	860	893	926	959	992	*024
32	12057	090	123	156	189	222	254	287	320	352
33	385	418	450	483	516	548	581	613	646	678
34	710	743	775	808	840	872	905	937	969	*001
35	13033	066	098	130	162	194	226	258	290	322
36	354	386	418	450	481	513	545	577	609	640
37	672	704	735	767	799	830	862	893	925	956
38	988	*019	*051	*082	*114	*145	*176	*208	*239	*270
39	14301	333	364	395	426	457	489	520	551	582
140	613	644	675	706	737	768	799	829	860	891
41	922	953	983	*014	*045	*076	*106	*137	*168	*198
42	15229	259	290	320	351	381	412	442	473	503
43	534	564	594	625	655	685	715	746	776	806
44	836	866	897	927	957	987	*017	*047	*077	*107
45	16137	167	197	227	256	286	316	346	376	406
46	435	465	495	524	554	584	613	643	673	702
47	732	761	791	820	850	879	909	938	967	997
48	17026	056	085	114	143	173	202	231	260	289
49	319	348	377	406	435	464	493	522	551	580
150	609	638	667	696	725	754	782	811	840	869
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	44	43	42
1	4.4	4.3	4.2
2	8.8	8.6	8.4
3	13.2	12.9	12.6
4	17.6	17.2	16.8
5	22.0	21.5	21.0
6	26.4	25.8	25.2
7	30.8	30.1	29.4
8	35.2	34.4	33.6
9	39.6	38.7	37.8

	41	40	39
1	4.1	4.0	3.9
2	8.2	8.0	7.8
3	12.3	12.0	11.7
4	16.4	16.0	15.6
5	20.5	20.0	19.5
6	24.6	24.0	23.4
7	28.7	28.0	27.3
8	32.8	32.0	31.2
9	36.9	36.0	35.1

	38	37	36
1	3.8	3.7	3.6
2	7.6	7.4	7.2
3	11.4	11.1	10.8
4	15.2	14.8	14.4
5	19.0	18.5	18.0
6	22.8	22.2	21.6
7	26.6	25.9	25.2
8	30.4	29.6	28.8
9	34.2	33.3	32.4

	35	34	33
1	3.5	3.4	3.3
2	7.0	6.8	6.6
3	10.5	10.2	9.9
4	14.0	13.6	13.2
5	17.5	17.0	16.5
6	21.0	20.4	19.8
7	24.5	23.8	23.1
8	28.0	27.2	26.4
9	31.5	30.6	29.7

	32	31	30
1	3.2	3.1	3.0
2	6.4	6.2	6.0
3	9.6	9.3	9.0
4	12.8	12.4	12.0
5	16.0	15.5	15.0
6	19.2	18.6	18.0
7	22.4	21.7	21.0
8	25.6	24.8	24.0
9	28.8	27.9	27.0

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
150	17 609	638	667	696	725	754	782	811	840	869
51	898	926	955	984	*013	*041	*070	*099	*127	*156
52	18 184	213	241	270	298	327	355	384	412	441
53	469	498	526	554	583	611	639	667	696	724
54	752	780	808	837	865	893	921	949	977	*005
55	19 033	061	089	117	145	173	201	229	257	285
56	312	340	368	396	424	451	479	507	535	562
57	590	618	645	673	700	728	756	783	811	838
58	866	893	921	948	976	*003	*030	*058	*085	*112
59	20 140	167	194	222	249	276	303	330	358	385
160	412	439	466	493	520	548	575	602	629	656
61	683	710	737	763	790	817	844	871	898	925
62	952	978	*005	*032	*059	*085	*112	*139	*165	*192
63	21 219	245	272	299	325	352	378	405	431	458
64	484	511	537	564	590	617	643	669	696	722
65	748	775	801	827	854	880	906	932	958	985
66	22 011	037	063	089	115	141	167	194	220	246
67	272	298	324	350	376	401	427	453	479	505
68	531	557	583	608	634	660	686	712	737	763
69	789	814	840	866	891	917	943	968	994	*019
170	23 045	070	096	121	147	172	198	223	249	274
71	300	325	350	376	401	426	452	477	502	528
72	553	578	603	629	654	679	704	729	754	779
73	805	830	855	880	905	930	955	980	*005	*030
74	24 055	080	105	130	155	180	204	229	254	279
75	304	329	353	378	403	428	452	477	502	527
76	551	576	601	625	650	674	699	724	748	773
77	797	822	846	871	895	920	944	969	993	*018
78	25 042	066	091	115	139	164	188	212	237	261
79	285	310	334	358	382	406	431	455	479	503
180	527	551	575	600	624	648	672	696	720	744
81	768	792	816	840	864	888	912	935	959	983
82	26 007	031	055	079	102	126	150	174	198	221
83	245	269	293	316	340	364	387	411	435	458
84	482	505	529	553	576	600	623	647	670	694
85	717	741	764	788	811	834	858	881	905	928
86	951	975	998	*021	*045	*068	*091	*114	*138	*161
87	27 184	207	231	254	277	300	323	346	370	393
88	416	439	462	485	508	531	554	577	600	623
89	646	669	692	715	738	761	784	807	830	852
190	875	898	921	944	967	989	*012	*035	*058	*081
91	28 103	126	149	171	194	217	240	262	285	307
92	330	353	375	398	421	443	466	488	511	533
93	556	578	601	623	646	668	691	713	735	758
94	780	803	825	847	870	892	914	937	959	981
95	29 003	026	048	070	092	115	137	159	181	203
96	226	248	270	292	314	336	358	380	403	425
97	447	469	491	513	535	557	579	601	623	645
98	667	688	710	732	754	776	798	820	842	863
99	885	907	929	951	973	994	*016	*038	*060	*081
200	30 103	125	146	168	190	211	233	255	276	298
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.

	29	28	27
1	2.9	2.8	2.7
2	5.8	5.6	5.4
3	8.7	8.4	8.1
4	11.6	11.2	10.8
5	14.5	14.0	13.5
6	17.4	16.8	16.2
7	20.3	19.6	18.9
8	23.2	22.4	21.6
9	26.1	25.2	24.3

	26	25	24
1	2.6	2.5	2.4
2	5.2	5.0	4.8
3	7.8	7.5	7.2
4	10.4	10.0	9.6
5	13.0	12.5	12.0
6	15.6	15.0	14.4
7	18.2	17.5	16.8
8	20.8	20.0	19.2
9	23.4	22.5	21.6

	23	22	21
1	2.3	2.2	2.1
2	4.6	4.4	4.2
3	6.9	6.6	6.3
4	9.2	8.8	8.4
5	11.5	11.0	10.5
6	13.8	13.2	12.6
7	16.1	15.4	14.7
8	18.4	17.6	16.8
9	20.7	19.8	18.9

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
200	30 103	125	146	168	190	211	233	255	276	298
01	320	341	363	384	406	428	449	471	492	514
02	535	557	578	600	621	643	664	685	707	728
03	750	771	792	814	835	856	878	899	920	942
04	963	984	*006	*027	*048	*069	*091	*112	*133	*154
05	31 175	197	218	239	260	281	302	323	345	366
06	387	408	429	450	471	492	513	534	555	576
07	597	618	639	660	681	702	723	744	765	785
08	806	827	848	869	890	911	931	952	973	994
09	32 015	035	056	077	098	118	139	160	181	201
210	222	243	263	284	305	325	346	366	387	408
11	428	449	469	490	510	531	552	572	593	613
12	634	654	675	695	715	736	756	777	797	818
13	838	858	879	899	919	940	960	980	*001	*021
14	33 041	062	082	102	122	143	163	183	203	224
15	244	264	284	304	325	345	365	385	405	425
16	445	465	486	506	526	546	566	586	606	626
17	646	666	686	706	726	746	766	786	806	826
18	846	866	885	905	925	945	965	985	*005	*025
19	34 044	064	084	104	124	143	163	183	203	223
220	242	262	282	301	321	341	361	380	400	420
21	439	459	479	498	518	537	557	577	596	616
22	635	655	674	694	713	733	753	772	792	811
23	830	850	869	889	908	928	947	967	986	*005
24	35 025	044	064	083	102	122	141	160	180	199
25	218	238	257	276	295	315	334	353	372	392
26	411	430	449	468	488	507	526	545	564	583
27	603	622	641	660	679	698	717	736	755	774
28	793	813	832	851	870	889	908	927	946	965
29	984	*003	*021	*040	*059	*078	*097	*116	*135	*154
230	36 173	192	211	229	248	267	286	305	324	342
31	361	380	399	418	436	455	474	493	511	530
32	549	568	586	605	624	642	661	680	698	717
33	736	754	773	791	810	829	847	866	884	903
34	922	940	959	977	996	*014	*033	*051	*070	*088
35	37 107	125	144	162	181	199	218	236	254	273
36	291	310	328	346	365	383	401	420	438	457
37	475	493	511	530	548	566	585	603	621	639
38	658	676	694	712	731	749	767	785	803	822
39	840	858	876	894	912	931	949	967	985	*003
240	38 021	039	057	075	093	112	130	148	166	184
41	202	220	238	256	274	292	310	328	346	364
42	382	399	417	435	453	471	489	507	525	543
43	561	578	596	614	632	650	668	686	703	721
44	739	757	775	792	810	828	846	863	881	899
45	917	934	952	970	987	*005	*023	*041	*058	*076
46	39 094	111	129	146	164	182	199	217	235	252
47	270	287	305	322	340	358	375	393	410	428
48	445	463	480	498	515	533	550	568	585	602
49	620	637	655	672	690	707	724	742	759	777
250	794	811	829	846	863	881	898	915	933	950
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.

	22	21	20
1	2.2	2.1	2.0
2	4.4	4.2	4.0
3	6.6	6.3	6.0
4	8.8	8.4	8.0
5	11.0	10.5	10.0
6	13.2	12.6	12.0
7	15.4	14.7	14.0
8	17.6	16.8	16.0
9	19.8	18.9	18.0

	19	18	17
1	1.9	1.8	1.7
2	3.8	3.6	3.4
3	5.7	5.4	5.1
4	7.6	7.2	6.8
5	9.5	9.0	8.5
6	11.4	10.8	10.2
7	13.3	12.6	11.9
8	15.2	14.4	13.6
9	17.1	16.2	15.3

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
250	39 794	811	829	846	863	881	898	915	933	950
51	967	985	*002	*019	*037	*054	*071	*088	*106	*123
52	40 140	157	175	192	209	226	243	261	278	295
53	312	329	346	364	381	398	415	432	449	466
54	483	500	518	535	552	569	586	603	620	637
55	654	671	688	705	722	739	756	773	790	807
56	824	841	858	875	892	909	926	943	960	976
57	993	*010	*027	*044	*061	*078	*095	*111	*128	*145
58	41 162	179	196	212	229	246	263	280	296	313
59	330	347	363	380	397	414	430	447	464	481
260	497	514	531	547	564	581	597	614	631	647
61	664	681	697	714	731	747	764	780	797	814
62	830	847	863	880	896	913	929	946	963	979
63	996	*012	*029	*045	*062	*078	*095	*111	*127	*144
64	42 160	177	193	210	226	243	259	275	292	308
65	325	341	357	374	390	406	423	439	455	472
66	488	504	521	537	553	570	586	602	619	635
67	651	667	684	700	716	732	749	765	781	797
68	813	830	846	862	878	894	911	927	943	959
69	975	991	*008	*024	*040	*056	*072	*088	*104	*120
270	43 136	152	169	185	201	217	233	249	265	281
71	297	313	329	345	361	377	393	409	425	441
72	457	473	489	505	521	537	553	569	584	600
73	616	632	648	664	680	696	712	727	743	759
74	775	791	807	823	838	854	870	886	902	917
75	933	949	965	981	996	*012	*028	*044	*059	*075
76	44 091	107	122	138	154	170	185	201	217	232
77	248	264	279	295	311	326	342	358	373	389
78	404	420	436	451	467	483	498	514	529	545
79	560	576	592	607	623	638	654	669	685	700
280	716	731	747	762	778	793	809	824	840	855
81	871	886	902	917	932	948	963	979	994	*010
82	45 025	040	056	071	086	102	117	133	148	163
83	179	194	209	225	240	255	271	286	301	317
84	332	347	362	378	393	408	423	439	454	469
85	484	500	515	530	545	561	576	591	606	621
86	637	652	667	682	697	712	728	743	758	773
87	788	803	818	834	849	864	879	894	909	924
88	939	954	969	984	*000	*015	*030	*045	*060	*075
89	46 090	105	120	135	150	165	180	195	210	225
290	240	255	270	285	300	315	330	345	359	374
91	389	404	419	434	449	464	479	494	509	523
92	538	553	568	583	598	613	627	642	657	672
93	687	702	716	731	746	761	776	790	805	820
94	835	850	864	879	894	909	923	938	953	967
95	982	997	*012	*026	*041	*056	*070	*085	*100	*114
96	47 129	144	159	173	188	202	217	232	246	261
97	276	290	305	319	334	349	363	378	392	407
98	422	436	451	465	480	494	509	524	538	553
99	567	582	596	611	625	640	654	669	683	698
300	712	727	741	756	770	784	799	813	828	842
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	18	17	16
1	1.8	1.7	1.6
2	3.6	3.4	3.2
3	5.4	5.1	4.8
4	7.2	6.8	6.4
5	9.0	8.5	8.0
6	10.8	10.2	9.6
7	12.6	11.9	11.2
8	14.4	13.6	12.8
9	16.2	15.3	14.4

	15	14
1	1.5	1.4
2	3.0	2.8
3	4.5	4.2
4	6.0	5.6
5	7.5	7.0
6	9.0	8.4
7	10.5	9.8
8	12.0	11.2
9	13.5	12.6

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
300	47 712	727	741	756	770	784	799	813	828	842
01	857	871	885	900	914	929	943	958	972	986
02	48 001	015	029	044	058	073	087	101	116	130
03	144	159	173	187	202	216	230	244	259	273
04	287	302	316	330	344	359	373	387	401	416
05	430	444	458	473	487	501	515	530	544	558
06	572	586	601	615	629	643	657	671	686	700
07	714	728	742	756	770	785	799	813	827	841
08	855	869	883	897	911	926	940	954	968	982
09	996	*010	*024	*038	*052	*066	*080	*094	*108	*122
310	49 136	150	164	178	192	206	220	234	248	262
11	276	290	304	318	332	346	360	374	388	402
12	415	429	443	457	471	485	499	513	527	541
13	554	568	582	596	610	624	638	651	665	679
14	693	707	721	734	748	762	776	790	803	817
15	831	845	859	872	886	900	914	927	941	955
16	969	982	996	*010	*024	*037	*051	*065	*079	*092
17	50 106	120	133	147	161	174	188	202	215	229
18	243	256	270	284	297	311	325	338	352	365
19	379	393	406	420	433	447	461	474	488	501
320	515	529	542	556	569	583	596	610	623	637
21	651	664	678	691	705	718	732	745	759	772
22	786	799	813	826	840	853	866	880	893	907
23	920	934	947	961	974	987	*001	*014	*028	*041
24	51 055	068	081	095	108	121	135	148	162	175
25	188	202	215	228	242	255	268	282	295	308
26	322	335	348	362	375	388	402	415	428	441
27	455	468	481	495	508	521	534	548	561	574
28	587	601	614	627	640	654	667	680	693	706
29	720	733	746	759	772	786	799	812	825	838
330	851	865	878	891	904	917	930	943	957	970
31	983	996	*009	*022	*035	*048	*061	*075	*088	*101
32	52 114	127	140	153	166	179	192	205	218	231
33	244	257	270	284	297	310	323	336	349	362
34	375	388	401	414	427	440	453	466	479	492
35	504	517	530	543	556	569	582	595	608	621
36	634	647	660	673	686	699	711	724	737	750
37	763	776	789	802	815	827	840	853	866	879
38	892	905	917	930	943	956	969	982	994	*007
39	53 020	033	046	058	071	084	097	110	122	135
340	148	161	173	186	199	212	224	237	250	263
41	275	288	301	314	326	339	352	364	377	390
42	403	415	428	441	453	466	479	491	504	517
43	529	542	555	567	580	593	605	618	631	643
44	656	668	681	694	706	719	732	744	757	769
45	782	794	807	820	832	845	857	870	882	895
46	908	920	933	945	958	970	983	995	*008	*020
47	54 033	045	058	070	083	095	108	120	133	145
48	158	170	183	195	208	220	233	245	258	270
49	283	295	307	320	332	345	357	370	382	394
350	407	419	432	444	456	469	481	494	506	518
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.

	15	14
1	1.5	1.4
2	3.0	2.8
3	4.5	4.2
4	6.0	5.6
5	7.5	7.0
6	9.0	8.4
7	10.5	9.8
8	12.0	11.2
9	13.5	12.6

	13	12
1	1.3	1.2
2	2.6	2.4
3	3.9	3.6
4	5.2	4.8
5	6.5	6.0
6	7.8	7.2
7	9.1	8.4
8	10.4	9.6
9	11.7	10.8

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
350	54 407	419	432	444	456	469	481	494	506	518
51	531	543	555	568	580	593	605	617	630	642
52	654	667	679	691	704	716	728	741	753	765
53	777	790	802	814	827	839	851	864	876	888
54	900	913	925	937	949	962	974	986	998	*011
55	55 023	035	047	060	072	084	096	108	121	133
56	145	157	169	182	194	206	218	230	242	255
57	267	279	291	303	315	328	340	352	364	376
58	388	400	413	425	437	449	461	473	485	497
59	509	522	534	546	558	570	582	594	606	618
360	630	642	654	666	678	691	703	715	727	739
61	751	763	775	787	799	811	823	835	847	859
62	871	883	895	907	919	931	943	955	967	979
63	991	*003	*015	*027	*038	*050	*062	*074	*086	*098
64	56 110	122	134	146	158	170	182	194	205	217
65	229	241	253	265	277	289	301	312	324	336
66	348	360	372	384	396	407	419	431	443	455
67	467	478	490	502	514	526	538	549	561	573
68	585	597	608	620	632	644	656	667	679	691
69	703	714	726	738	750	761	773	785	797	808
370	820	832	844	855	867	879	891	902	914	926
71	937	949	961	972	984	996	*008	*019	*031	*043
72	57 054	066	078	089	101	113	124	136	148	159
73	171	183	194	206	217	229	241	252	264	276
74	287	299	310	322	334	345	357	368	380	392
75	403	415	426	438	449	461	473	484	496	507
76	519	530	542	553	565	576	588	600	611	623
77	634	646	657	669	680	692	703	715	726	738
78	749	761	772	784	795	807	818	830	841	852
79	864	875	887	898	910	921	933	944	955	967
380	978	990	*001	*013	*024	*035	*047	*058	*070	*081
81	58 092	104	115	127	138	149	161	172	184	195
82	206	218	229	240	252	263	274	286	297	309
83	320	331	343	354	365	377	388	399	410	422
84	433	444	456	467	478	490	501	512	524	535
85	546	557	569	580	591	602	614	625	636	647
86	659	670	681	692	704	715	726	737	749	760
87	771	782	794	805	816	827	838	850	861	872
88	883	894	906	917	928	939	950	961	973	984
89	995	*006	*017	*028	*040	*051	*062	*073	*084	*095
390	59 106	118	129	140	151	162	173	184	195	207
91	218	229	240	251	262	273	284	295	306	318
92	329	340	351	362	373	384	395	406	417	428
93	439	450	461	472	483	494	506	517	528	539
94	550	561	572	583	594	605	616	627	638	649
95	660	671	682	693	704	715	726	737	748	759
96	770	780	791	802	813	824	835	846	857	868
97	879	890	901	912	923	934	945	956	966	977
98	988	999	*010	*021	*032	*043	*054	*065	*076	*086
99	60 097	108	119	130	141	152	163	173	184	195
400	206	217	228	239	249	260	271	282	293	304
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	13	12
1	1.3	1.2
2	2.6	2.4
3	3.9	3.6
4	5.2	4.8
5	6.5	6.0
6	7.8	7.2
7	9.1	8.4
8	10.4	9.6
9	11.7	10.8

	11	10
1	1.1	1.0
2	2.2	2.0
3	3.3	3.0
4	4.4	4.0
5	5.5	5.0
6	6.6	6.0
7	7.7	7.0
8	8.8	8.0
9	9.9	9.0

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
400	60 206	217	228	239	249	260	271	282	293	304
01	314	325	336	347	358	369	379	390	401	412
02	423	433	444	455	466	477	487	498	509	520
03	531	541	552	563	574	584	595	606	617	627
04	638	649	660	670	681	692	703	713	724	735
05	746	756	767	778	788	799	810	821	831	842
06	853	863	874	885	895	906	917	927	938	949
07	959	970	981	991	*002	*013	*023	*034	*045	*055
08	61 066	077	087	098	109	119	130	140	151	162
09	172	183	194	204	215	225	236	247	257	268
410	278	289	300	310	321	331	342	352	363	374
11	384	395	405	416	426	437	448	458	469	479
12	490	500	511	521	532	542	553	563	574	584
13	595	606	616	627	637	648	658	669	679	690
14	700	711	721	731	742	752	763	773	784	794
15	805	815	826	836	847	857	868	878	888	899
16	909	920	930	941	951	962	972	982	993	*003
17	62 014	024	034	045	055	066	076	086	097	107
18	118	128	138	149	159	170	180	190	201	211
19	221	232	242	252	263	273	284	294	304	315
420	325	335	346	356	366	377	387	397	408	418
21	428	439	449	459	469	480	490	500	511	521
22	531	542	552	562	572	583	593	603	613	624
23	634	644	655	665	675	685	696	706	716	726
24	737	747	757	767	778	788	798	808	818	829
25	839	849	859	870	880	890	900	910	921	931
26	941	951	961	972	982	992	*002	*012	*022	*033
27	63 043	053	063	073	083	094	104	114	124	134
28	144	155	165	175	185	195	205	215	225	236
29	246	256	266	276	286	296	306	317	327	337
430	347	357	367	377	387	397	407	417	428	438
31	448	458	468	478	488	498	508	518	528	538
32	548	558	568	579	589	599	609	619	629	639
33	649	659	669	679	689	699	709	719	729	739
34	749	759	769	779	789	799	809	819	829	839
35	849	859	869	879	889	899	909	919	929	939
36	949	959	969	979	988	998	*008	*018	*028	*038
37	64 048	058	068	078	088	098	108	118	128	137
38	147	157	167	177	187	197	207	217	227	237
39	246	256	266	276	286	296	306	316	326	335
440	345	355	365	375	385	395	404	414	424	434
41	444	454	464	473	483	493	503	513	523	532
42	542	552	562	572	582	591	601	611	621	631
43	640	650	660	670	680	689	699	709	719	729
44	738	748	758	768	777	787	797	807	816	826
45	836	846	856	865	875	885	895	904	914	924
46	933	943	953	963	972	982	992	*002	*011	*021
47	65 031	040	050	060	070	079	089	099	108	118
48	128	137	147	157	167	176	186	196	205	215
49	225	234	244	254	263	273	283	292	302	312
450	321	331	341	350	360	369	379	389	398	408
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	11	10	9
1	1.1	1.0	0.9
2	2.2	2.0	1.8
3	3.3	3.0	2.7
4	4.4	4.0	3.6
5	5.5	5.0	4.5
6	6.6	6.0	5.4
7	7.7	7.0	6.3
8	8.8	8.0	7.2
9	9.9	9.0	8.1

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
450	65 321	331	341	350	360	369	379	389	398	408	
51	418	427	437	447	456	466	475	485	495	504	
52	514	523	533	543	552	562	571	581	591	600	
53	610	619	629	639	648	658	667	677	686	696	
54	706	715	725	734	744	753	763	772	782	792	
55	801	811	820	830	839	849	858	868	877	887	
56	896	906	916	925	935	944	954	963	973	982	
57	992	*001	*011	*020	*030	*039	*049	*058	*068	*077	
58	66 087	096	106	115	124	134	143	153	162	172	
59	181	191	200	210	219	229	238	247	257	266	
460	276	285	295	304	314	323	332	342	351	361	
61	370	380	389	398	408	417	427	436	445	455	
62	464	474	483	492	502	511	521	530	539	549	
63	558	567	577	586	596	605	614	624	633	642	
64	652	661	671	680	689	699	708	717	727	736	
65	745	755	764	773	783	792	801	811	820	829	
66	839	848	857	867	876	885	894	904	913	922	
67	932	941	950	960	969	978	987	997	*006	*015	
68	67 025	034	043	052	062	071	080	089	099	108	
69	117	127	136	145	154	164	173	182	191	201	
470	210	219	228	237	247	256	265	274	284	293	
71	302	311	321	330	339	348	357	367	376	385	
72	394	403	413	422	431	440	449	459	468	477	
73	486	495	504	514	523	532	541	550	560	569	
74	578	587	596	605	614	624	633	642	651	660	
75	669	679	688	697	706	715	724	733	742	752	
76	761	770	779	788	797	806	815	825	834	843	
77	852	861	870	879	888	897	906	916	925	934	
78	943	952	961	970	979	988	997	*006	*015	*024	
79	68 034	043	052	061	070	079	088	097	106	115	
480	124	133	142	151	160	169	178	187	196	205	
81	215	224	233	242	251	260	269	278	287	296	
82	305	314	323	332	341	350	359	368	377	386	
83	395	404	413	422	431	440	449	458	467	476	
84	485	494	502	511	520	529	538	547	556	565	
85	574	583	592	601	610	619	628	637	646	655	
86	664	673	681	690	699	708	717	726	735	744	
87	753	762	771	780	789	797	806	815	824	833	
88	842	851	860	869	878	886	895	904	913	922	
89	931	940	949	958	966	975	984	993	*002	*011	
490	69 020	028	037	046	055	064	073	082	090	099	
91	108	117	126	135	144	152	161	170	179	188	
92	197	205	214	223	232	241	249	258	267	276	
93	285	294	302	311	320	329	338	346	355	364	
94	373	381	390	399	408	417	425	434	443	452	
95	461	469	478	487	496	504	513	522	531	539	
96	548	557	566	574	583	592	601	609	618	627	
97	636	644	653	662	671	679	688	697	705	714	
98	723	732	740	749	758	767	775	784	793	801	
99	810	819	827	836	845	854	862	871	880	888	
500	897	906	914	923	932	940	949	958	966	975	
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

Prop. Pts.:

	10	**9**	**8**
1	1.0	0.9	0.8
2	2.0	1.8	1.6
3	3.0	2.7	2.4
4	4.0	3.6	3.2
5	5.0	4.5	4.0
6	6.0	5.4	4.8
7	7.0	6.3	5.6
8	8.0	7.2	6.4
9	9.0	8.1	7.2

	0	1	2	3	4	5	6	7	8	9
500	69 897	906	914	923	932	940	949	958	966	975
01	984	992	*001	*010	*018	*027	*036	*044	*053	*062
02	70 070	079	088	096	105	114	122	131	140	148
03	157	165	174	183	191	200	209	217	226	234
04	243	252	260	269	278	286	295	303	312	321
05	329	338	346	355	364	372	381	389	398	406
06	415	424	432	441	449	458	467	475	484	492
07	501	509	518	526	535	544	552	561	569	578
08	586	595	603	612	621	629	638	646	655	663
09	672	680	689	697	706	714	723	731	740	749
510	757	766	774	783	791	800	808	817	825	834
11	842	851	859	868	876	885	893	902	910	919
12	927	935	944	952	961	969	978	986	995	*003
13	71 012	020	029	037	046	054	063	071	079	088
14	096	105	113	122	130	139	147	155	164	172
15	181	189	198	206	214	223	231	240	248	257
16	265	273	282	290	299	307	315	324	332	341
17	349	357	366	374	383	391	399	408	416	425
18	433	441	450	458	466	475	483	492	500	508
19	517	525	533	542	550	559	567	575	584	592
520	600	609	617	625	634	642	650	659	667	675
21	684	692	700	709	717	725	734	742	750	759
22	767	775	784	792	800	809	817	825	834	842
23	850	858	867	875	883	892	900	908	917	925
24	933	941	950	958	966	975	983	991	999	*008
25	72 016	024	032	041	049	057	066	074	082	090
26	099	107	115	123	132	140	148	156	165	173
27	181	189	198	206	214	222	230	239	247	255
28	263	272	280	288	296	304	313	321	329	337
29	346	354	362	370	378	387	395	403	411	419
530	428	436	444	452	460	469	477	485	493	501
31	509	518	526	534	542	550	558	567	575	583
32	591	599	607	616	624	632	640	648	656	665
33	673	681	689	697	705	713	722	730	738	746
34	754	762	770	779	787	795	803	811	819	827
35	835	843	852	860	868	876	884	892	900	908
36	916	925	933	941	949	957	965	973	981	989
37	997	*006	*014	*022	*030	*038	*046	*054	*062	*070
38	73 078	086	094	102	111	119	127	135	143	151
39	159	167	175	183	191	199	207	215	223	231
540	239	247	255	263	272	280	288	296	304	312
41	320	328	336	344	352	360	368	376	384	392
42	400	408	416	424	432	440	448	456	464	472
43	480	488	496	504	512	520	528	536	544	552
44	560	568	576	584	592	600	608	616	624	632
45	640	648	656	664	672	679	687	695	703	711
46	719	727	735	743	751	759	767	775	783	791
47	799	807	815	823	830	838	846	854	862	870
48	878	886	894	902	910	918	926	933	941	949
49	957	965	973	981	989	997	*005	*013	*020	*028
550	74 036	044	052	060	068	076	084	092	099	107
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	9	8	7
1	0.9	0.8	0.7
2	1.8	1.6	1.4
3	2.7	2.4	2.1
4	3.6	3.2	2.8
5	4.5	4.0	3.5
6	5.4	4.8	4.2
7	6.3	5.6	4.9
8	7.2	6.4	5.6
9	8.1	7.2	6.3

	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
550	74 036	044	052	060	068	076	084	092	099	107	
51	115	123	131	139	147	155	162	170	178	186	
52	194	202	210	218	225	233	241	249	257	265	
53	273	280	288	296	304	312	320	327	335	343	
54	351	359	367	374	382	390	398	406	414	421	
55	429	437	445	453	461	468	476	484	492	500	
56	507	515	523	531	539	547	554	562	570	578	
57	586	593	601	609	617	624	632	640	648	656	
58	663	671	679	687	695	702	710	718	726	733	
59	741	749	757	764	772	780	788	796	803	811	
560	819	827	834	842	850	858	865	873	881	889	
61	896	904	912	920	927	935	943	950	958	966	
62	974	981	989	997	*005	*012	*020	*028	*035	*043	
63	75 051	059	066	074	082	089	097	105	113	120	
64	128	136	143	151	159	166	174	182	189	197	
65	205	213	220	228	236	243	251	259	266	274	
66	282	289	297	305	312	320	328	335	343	351	
67	358	366	374	381	389	397	404	412	420	427	
68	435	442	450	458	465	473	481	488	496	504	
69	511	519	526	534	542	549	557	565	572	580	
570	587	595	603	610	618	626	633	641	648	656	
71	664	671	679	686	694	702	709	717	724	732	
72	740	747	755	762	770	778	785	793	800	808	
73	815	823	831	838	846	853	861	868	876	884	
74	891	899	906	914	921	929	937	944	952	959	
75	967	974	982	989	997	*005	*012	*020	*027	*035	
76	76 042	050	057	065	072	080	087	095	103	110	
77	118	125	133	140	148	155	163	170	178	185	
78	193	200	208	215	223	230	238	245	253	260	
79	268	275	283	290	298	305	313	320	328	335	
580	343	350	358	365	373	380	388	395	403	410	
81	418	425	433	440	448	455	462	470	477	485	
82	492	500	507	515	522	530	537	545	552	559	
83	567	574	582	589	597	604	612	619	626	634	
84	641	649	656	664	671	678	686	693	701	708	
85	716	723	730	738	745	753	760	768	775	782	
86	790	797	805	812	819	827	834	842	849	856	
87	864	871	879	886	893	901	908	916	923	930	
88	938	945	953	960	967	975	982	989	997	*004	
89	77 012	019	026	034	041	048	056	063	070	078	
590	085	093	100	107	115	122	129	137	144	151	
91	159	166	173	181	188	195	203	210	217	225	
92	232	240	247	254	262	269	276	283	291	298	
93	305	313	320	327	335	342	349	357	364	371	
94	379	386	393	401	408	415	422	430	437	444	
95	452	459	466	474	481	488	495	503	510	517	
96	525	532	539	546	554	561	568	576	583	590	
97	597	605	612	619	627	634	641	648	656	663	
98	670	677	685	692	699	706	714	721	728	735	
99	743	750	757	764	772	779	786	793	801	808	
600	815	822	830	837	844	851	859	866	873	880	
	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

Prop. Pts.

	8	7
1	0.8	0.7
2	1.6	1.4
3	2.4	2.1
4	3.2	2.8
5	4.0	3.5
6	4.8	4.2
7	5.6	4.9
8	6.4	5.6
9	7.2	6.3

	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
600	77 815	822	830	837	844	851	859	866	873	880	
01	887	895	902	909	916	924	931	938	945	952	
02	960	967	974	981	988	996	*003	*010	*017	*025	
03	78 032	039	046	053	061	068	075	082	089	097	
04	104	111	118	125	132	140	147	154	161	168	
05	176	183	190	197	204	211	219	226	233	240	
06	247	254	262	269	276	283	290	297	305	312	
07	319	326	333	340	347	355	362	369	376	383	
08	390	398	405	412	419	426	433	440	447	455	
09	462	469	476	483	490	497	504	512	519	526	
610	533	540	547	554	561	569	576	583	590	597	
11	604	611	618	625	633	640	647	654	661	668	
12	675	682	689	696	704	711	718	725	732	739	
13	746	753	760	767	774	781	789	796	803	810	
14	817	824	831	838	845	852	859	866	873	880	
15	888	895	902	909	916	923	930	937	944	951	
16	958	965	972	979	986	993	*000	*007	*014	*021	
17	79 029	036	043	050	057	064	071	078	085	092	
18	099	106	113	120	127	134	141	148	155	162	
19	169	176	183	190	197	204	211	218	225	232	
620	239	246	253	260	267	274	281	288	295	302	
21	309	316	323	330	337	344	351	358	365	372	
22	379	386	393	400	407	414	421	428	435	442	
23	449	456	463	470	477	484	491	498	505	511	
24	518	525	532	539	546	553	560	567	574	581	
25	588	595	602	609	616	623	630	637	644	650	
26	657	664	671	678	685	692	699	706	713	720	
27	727	734	741	748	754	761	768	775	782	789	
28	796	803	810	817	824	831	837	844	851	858	
29	865	872	879	886	893	900	906	913	920	927	
630	934	941	948	955	962	969	975	982	989	996	
31	80 003	010	017	024	030	037	044	051	058	065	
32	072	079	085	092	099	106	113	120	127	134	
33	140	147	154	161	168	175	182	188	195	202	
34	209	216	223	229	236	243	250	257	264	271	
35	277	284	291	298	305	312	318	325	332	339	
36	346	353	359	366	373	380	387	393	400	407	
37	414	421	428	434	441	448	455	462	468	475	
38	482	489	496	502	509	516	523	530	536	543	
39	550	557	564	570	577	584	591	598	604	611	
640	618	625	632	638	645	652	659	665	672	679	
41	686	693	699	706	713	720	726	733	740	747	
42	754	760	767	774	781	787	794	801	808	814	
43	821	828	835	841	848	855	862	868	875	882	
44	889	895	902	909	916	922	929	936	943	949	
45	956	963	969	976	983	990	996	*003	*010	*017	
46	81 023	030	037	043	050	057	064	070	077	084	
47	090	097	104	111	117	124	131	137	144	151	
48	158	164	171	178	184	191	198	204	211	218	
49	224	231	238	245	251	258	265	271	278	285	
650	291	298	305	311	318	325	331	338	345	351	
	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

Prop. Pts.

	8	7	6
1	0.8	0.7	0.6
2	1.6	1.4	1.2
3	2.4	2.1	1.8
4	3.2	2.8	2.4
5	4.0	3.5	3.0
6	4.8	4.2	3 6
7	5.6	4.9	4.2
8	6.4	5.6	4.8
9	7.2	6.3	5.4

	0	1	2	3	4	5	6	7	8	9
650	81 291	298	305	311	318	325	331	338	345	351
51	358	365	371	378	385	391	398	405	411	418
52	425	431	438	445	451	458	465	471	478	485
53	491	498	505	511	518	525	531	538	544	551
54	558	564	571	578	584	591	598	604	611	617
55	624	631	637	644	651	657	664	671	677	684
56	690	697	704	710	717	723	730	737	743	750
57	757	763	770	776	783	790	796	803	809	816
58	823	829	836	842	849	856	862	869	875	882
59	889	895	902	908	915	921	928	935	941	948
660	954	961	968	974	981	987	994	*000	*007	*014
61	82 020	027	033	040	046	053	060	066	073	079
62	086	092	099	105	112	119	125	132	138	145
63	151	158	164	171	178	184	191	197	204	210
64	217	223	230	236	243	249	256	263	269	276
65	282	289	295	302	308	315	321	328	334	341
66	347	354	360	367	373	380	387	393	400	406
67	413	419	426	432	439	445	452	458	465	471
68	478	484	491	497	504	510	517	523	530	536
69	543	549	556	562	569	575	582	588	595	601
670	607	614	620	627	633	640	646	653	659	666
71	672	679	685	692	698	705	711	718	724	730
72	737	743	750	756	763	769	776	782	789	795
73	802	808	814	821	827	834	840	847	853	860
74	866	872	879	885	892	898	905	911	918	924
75	930	937	943	950	956	963	969	975	982	988
76	995	*001	*008	*014	*020	*027	*033	*040	*046	*052
77	83 059	065	072	078	085	091	097	104	110	117
78	123	129	136	142	149	155	161	168	174	181
79	187	193	200	206	213	219	225	232	238	245
680	251	257	264	270	276	283	289	296	302	308
81	315	321	327	334	340	347	353	359	366	372
82	378	385	391	398	404	410	417	423	429	436
83	442	448	455	461	467	474	480	487	493	499
84	506	512	518	525	531	537	544	550	556	563
85	569	575	582	588	594	601	607	613	620	626
86	632	639	645	651	658	664	670	677	683	689
87	696	702	708	715	721	727	734	740	746	753
88	759	765	771	778	784	790	797	803	809	816
89	822	828	835	841	847	853	860	866	872	879
690	885	891	897	904	910	916	923	929	935	942
91	948	954	960	967	973	979	985	992	998	*004
92	84 011	017	023	029	036	042	048	055	061	067
93	073	080	086	092	098	105	111	117	123	130
94	136	142	148	155	161	167	173	180	186	192
95	198	205	211	217	223	230	236	242	248	255
96	261	267	273	280	286	292	298	305	311	317
97	323	330	336	342	348	354	361	367	373	379
98	386	392	398	404	410	417	423	429	435	442
99	448	454	460	466	473	479	485	491	497	504
700	510	516	522	528	535	541	547	553	559	566
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.

	7	6
1	0.7	0.6
2	1.4	1.2
3	2.1	1.8
4	2.8	2.4
5	3.5	3.0
6	4.2	3.6
7	4.9	4.2
8	5.6	4.8
9	6.3	5.4

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
700	84 510	516	522	528	535	541	547	553	559	566
01	572	578	584	590	597	603	609	615	621	628
02	634	640	646	652	658	665	671	677	683	689
03	696	702	708	714	720	726	733	739	745	751
04	757	763	770	776	782	788	794	800	807	813
05	819	825	831	837	844	850	856	862	868	874
06	880	887	893	899	905	911	917	924	930	936
07	942	948	954	960	967	973	979	985	991	997
08	85 003	009	016	022	028	034	040	046	052	058
09	065	071	077	083	089	095	101	107	114	120
710	126	132	138	144	150	156	163	169	175	181
11	187	193	199	205	211	217	224	230	236	242
12	248	254	260	266	272	278	285	291	297	303
13	309	315	321	327	333	339	345	352	358	364
14	370	376	382	388	394	400	406	412	418	425
15	431	437	443	449	455	461	467	473	479	485
16	491	497	503	509	516	522	528	534	540	546
17	552	558	564	570	576	582	588	594	600	606
18	612	618	625	631	637	643	649	655	661	667
19	673	679	685	691	697	703	709	715	721	727
720	733	739	745	751	757	763	769	775	781	788
21	794	800	806	812	818	824	830	836	842	848
22	854	860	866	872	878	884	890	896	902	908
23	914	920	926	932	938	944	950	956	962	968
24	974	980	986	992	998	*004	*010	*016	*022	*028
25	86 034	040	046	052	058	064	070	076	082	088
26	094	100	106	112	118	124	130	136	141	147
27	153	159	165	171	177	183	189	195	201	207
28	213	219	225	231	237	243	249	255	261	267
29	273	279	285	291	297	303	308	314	320	326
730	332	338	344	350	356	362	368	374	380	386
31	392	398	404	410	415	421	427	433	439	445
32	451	457	463	469	475	481	487	493	499	504
33	510	516	522	528	534	540	546	552	558	564
34	570	576	581	587	593	599	605	611	617	623
35	629	635	641	646	652	658	664	670	676	682
36	688	694	700	705	711	717	723	729	735	741
37	747	753	759	764	770	776	782	788	794	800
38	806	812	817	823	829	835	841	847	853	859
39	864	870	876	882	888	894	900	906	911	917
740	923	929	935	941	947	953	958	964	970	976
41	982	988	994	999	*005	*011	*017	*023	*029	*035
42	87 040	046	052	058	064	070	075	081	087	093
43	099	105	111	116	122	128	134	140	146	151
44	157	163	169	175	181	186	192	198	204	210
45	216	221	227	233	239	245	251	256	262	268
46	274	280	286	291	297	303	309	315	320	326
47	332	338	344	349	355	361	367	373	379	384
48	390	396	402	408	413	419	425	431	437	442
49	448	454	460	466	471	477	483	489	495	500
750	506	512	518	523	529	535	541	547	552	558
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	7	6	5
1	0.7	0.6	0.5
2	1.4	1.2	1.0
3	2.1	1.8	1.5
4	2.8	2.4	2.0
5	3.5	3.0	2.5
6	4.2	3.6	3.0
7	4.9	4.2	3.5
8	5.6	4.8	4.0
9	6.3	5.4	4.5

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
750	87 506	512	518	523	529	535	541	547	552	558
51	564	570	576	581	587	593	599	604	610	616
52	622	628	633	639	645	651	656	662	668	674
53	679	685	691	697	703	708	714	720	726	731
54	737	743	749	754	760	766	772	777	783	789
55	795	800	806	812	818	823	829	835	841	846
56	852	858	864	869	875	881	887	892	898	904
57	910	915	921	927	933	938	944	950	955	961
58	967	973	978	984	990	996	*001	*007	*013	*018
59	88 024	030	036	041	047	053	058	064	070	076
760	081	087	093	098	104	110	116	121	127	133
61	138	144	150	156	161	167	173	178	184	190
62	195	201	207	213	218	224	230	235	241	247
63	252	258	264	270	275	281	287	292	298	304
64	309	315	321	326	332	338	343	349	355	360
65	366	372	377	383	389	395	400	406	412	417
66	423	429	434	440	446	451	457	463	468	474
67	480	485	491	497	502	508	513	519	525	530
68	536	542	547	553	559	564	570	576	581	587
69	593	598	604	610	615	621	627	632	638	643
770	649	655	660	666	672	677	683	689	694	700
71	705	711	717	722	728	734	739	745	750	756
72	762	767	773	779	784	790	795	801	807	812
73	818	824	829	835	840	846	852	857	863	868
74	874	880	885	891	897	902	908	913	919	925
75	930	936	941	947	953	958	964	969	975	981
76	986	992	997	*003	*009	*014	*020	*025	*031	*037
77	89 042	048	053	059	064	070	076	081	087	092
78	098	104	109	115	120	126	131	137	143	148
79	154	159	165	170	176	182	187	193	198	204
780	209	215	221	226	232	237	243	248	254	260
81	265	271	276	282	287	293	298	304	310	315
82	321	326	332	337	343	348	354	360	365	371
83	376	382	387	393	398	404	409	415	421	426
84	432	437	443	448	454	459	465	470	476	481
85	487	492	498	504	509	515	520	526	531	537
86	542	548	553	559	564	570	575	581	586	592
87	597	603	609	614	620	625	631	636	642	647
88	653	658	664	669	675	680	686	691	697	702
89	708	713	719	724	730	735	741	746	752	757
790	763	768	774	779	785	790	796	801	807	812
91	818	823	829	834	840	845	851	856	862	867
92	873	878	883	889	894	900	905	911	916	922
93	927	933	938	944	949	955	960	966	971	977
94	982	988	993	998	*004	*009	*015	*020	*026	*031
95	90 037	042	048	053	059	064	069	075	080	086
96	091	097	102	108	113	119	124	129	135	140
97	146	151	157	162	168	173	179	184	189	195
98	200	206	211	217	222	227	233	238	244	249
99	255	260	266	271	276	282	287	293	298	304
800	309	314	320	325	331	336	342	347	352	358
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.

	6	5
1	0.6	0.5
2	1.2	1.0
3	1.8	1.5
4	2.4	2.0
5	3.0	2.5
6	3.6	3.0
7	4.2	3.5
8	4.8	4.0
9	5.4	4.5

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
800	90 309	314	320	325	331	336	342	347	352	358
01	363	369	374	380	385	390	396	401	407	412
02	417	423	428	434	439	445	450	455	461	466
03	472	477	482	488	493	499	504	509	515	520
04	526	531	536	542	547	553	558	563	569	574
05	580	585	590	596	601	607	612	617	623	628
06	634	639	644	650	655	660	666	671	677	682
07	687	693	698	703	709	714	720	725	730	736
08	741	747	752	757	763	768	773	779	784	789
09	795	800	806	811	816	822	827	832	838	843
810	849	854	859	865	870	875	881	886	891	897
11	902	907	913	918	924	929	934	940	945	950
12	956	961	966	972	977	982	988	993	998	*004
13	91 009	014	020	025	030	036	041	046	052	057
14	062	068	073	078	084	089	094	100	105	110
15	116	121	126	132	137	142	148	153	158	164
16	169	174	180	185	190	196	201	206	212	217
17	222	228	233	238	243	249	254	259	265	270
18	275	281	286	291	297	302	307	312	318	323
19	328	334	339	344	350	355	360	365	371	376
820	381	387	392	397	403	408	413	418	424	429
21	434	440	445	450	455	461	466	471	477	482
22	487	492	498	503	508	514	519	524	529	535
23	540	545	551	556	561	566	572	577	582	587
24	593	598	603	609	614	619	624	630	635	640
25	645	651	656	661	666	672	677	682	687	693
26	698	703	709	714	719	724	730	735	740	745
27	751	756	761	766	772	777	782	787	793	798
28	803	808	814	819	824	829	834	840	845	850
29	855	861	866	871	876	882	887	892	897	903
830	908	913	918	924	929	934	939	944	950	955
31	960	965	971	976	981	986	991	997	*002	*007
32	92 012	018	023	028	033	038	044	049	054	059
33	065	070	075	080	085	091	096	101	106	111
34	117	122	127	132	137	143	148	153	158	163
35	169	174	179	184	189	195	200	205	210	215
36	221	226	231	236	241	247	252	257	262	267
37	273	278	283	288	293	298	304	309	314	319
38	324	330	335	340	345	350	355	361	366	371
39	376	381	387	392	397	402	407	412	418	423
840	428	433	438	443	449	454	459	464	469	474
41	480	485	490	495	500	505	511	516	521	526
42	531	536	542	547	552	557	562	567	572	578
43	583	588	593	598	603	609	614	619	624	629
44	634	639	645	650	655	660	665	670	675	681
45	686	691	696	701	706	711	716	722	727	732
46	737	742	747	752	758	763	768	773	778	783
47	788	793	799	804	809	814	819	824	829	834
48	840	845	850	855	860	865	870	875	881	886
49	891	896	901	906	911	916	921	927	932	937
850	942	947	952	957	962	967	973	978	983	988
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	6	5
1	0.6	0.5
2	1.2	1.0
3	1.8	1.5
4	2.4	2.0
5	3.0	2.5
6	3.6	3.0
7	4.2	3.5
8	4.8	4.0
9	5.4	4.5

Prop. Pts.

N	0	1	2	3	4	5	6	7	8	9
850	92 942	947	952	957	962	967	973	978	983	988
51	993	998	*003	*008	*013	*018	*024	*029	*034	*039
52	93 044	049	054	059	064	069	075	080	085	090
53	095	100	105	110	115	120	125	131	136	141
54	146	151	156	161	166	171	176	181	186	192
55	197	202	207	212	217	222	227	232	237	242
56	247	252	258	263	268	273	278	283	288	293
57	298	303	308	313	318	323	328	334	339	344
58	349	354	359	364	369	374	379	384	389	394
59	399	404	409	414	420	425	430	435	440	445
860	450	455	460	465	470	475	480	485	490	495
61	500	505	510	515	520	526	531	536	541	546
62	551	556	561	566	571	576	581	586	591	596
63	601	606	611	616	621	626	631	636	641	646
64	651	656	661	666	671	676	682	687	692	697
65	702	707	712	717	722	727	732	737	742	747
66	752	757	762	767	772	777	782	787	792	797
67	802	807	812	817	822	827	832	837	842	847
68	852	857	862	867	872	877	882	887	892	897
69	902	907	912	917	922	927	932	937	942	947
870	952	957	962	967	972	977	982	987	992	997
71	94 002	007	012	017	022	027	032	037	042	047
72	052	057	062	067	072	077	082	086	091	096
73	101	106	111	116	121	126	131	136	141	146
74	151	156	161	166	171	176	181	186	191	196
75	201	206	211	216	221	226	231	236	240	245
76	250	255	260	265	270	275	280	285	290	295
77	300	305	310	315	320	325	330	335	340	345
78	349	354	359	364	369	374	379	384	389	394
79	399	404	409	414	419	424	429	433	438	443
880	448	453	458	463	468	473	478	483	488	493
81	498	503	507	512	517	522	527	532	537	542
82	547	552	557	562	567	571	576	581	586	591
83	596	601	606	611	616	621	626	630	635	640
84	645	650	655	660	665	670	675	680	685	689
85	694	699	704	709	714	719	724	729	734	738
86	743	748	753	758	763	768	773	778	783	787
87	792	797	802	807	812	817	822	827	832	836
88	841	846	851	856	861	866	871	876	880	885
89	890	895	900	905	910	915	919	924	929	934
890	939	944	949	954	959	963	968	973	978	983
91	988	993	998	*002	*007	*012	*017	*022	*027	*032
92	95 036	041	046	051	056	061	066	071	075	080
93	085	090	095	100	105	109	114	119	124	129
94	134	139	143	148	153	158	163	168	173	177
95	182	187	192	197	202	207	211	216	221	226
96	231	236	240	245	250	255	260	265	270	274
97	279	284	289	294	299	303	308	313	318	323
98	328	332	337	342	347	352	357	361	366	371
99	376	381	386	390	395	400	405	410	415	419
900	424	429	434	439	444	448	453	458	463	468
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	6	5	4
1	0.6	0.5	0.4
2	1.2	1.0	0.8
3	1.8	1.5	1.2
4	2.4	2.0	1.6
5	3.0	2.5	2.0
6	3.6	3.0	2.4
7	4.2	3.5	2.8
8	4.8	4.0	3.2
9	5.4	4.5	3.6

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
900	95 424	429	434	439	444	448	453	458	463	468
01	472	477	482	487	492	497	501	506	511	516
02	521	525	530	535	540	545	550	554	559	564
03	569	574	578	583	588	593	598	602	607	612
04	617	622	626	631	636	641	646	650	655	660
05	665	670	674	679	684	689	694	698	703	708
06	713	718	722	727	732	737	742	746	751	756
07	761	766	770	775	780	785	789	794	799	804
08	809	813	818	823	828	832	837	842	847	852
09	856	861	866	871	875	880	885	890	895	899
910	904	909	914	918	923	928	933	938	942	947
11	952	957	961	966	971	976	980	985	990	995
12	999	*004	*009	*014	*019	*023	*028	*033	*038	*042
13	96 047	052	057	061	066	071	076	080	085	090
14	095	099	104	109	114	118	123	128	133	137
15	142	147	152	156	161	166	171	175	180	185
16	190	194	199	204	209	213	218	223	227	232
17	237	242	246	251	256	261	265	270	275	280
18	284	289	294	298	303	308	313	317	322	327
19	332	336	341	346	350	355	360	365	369	374
920	379	384	388	393	398	402	407	412	417	421
21	426	431	435	440	445	450	454	459	464	468
22	473	478	483	487	492	497	501	506	511	515
23	520	525	530	534	539	544	548	553	558	562
24	567	572	577	581	586	591	595	600	605	609
25	614	619	624	628	633	638	642	647	652	656
26	661	666	670	675	680	685	689	694	699	703
27	708	713	717	722	727	731	736	741	745	750
28	755	759	764	769	774	778	783	788	792	797
29	802	806	811	816	820	825	830	834	839	844
930	848	853	858	862	867	872	876	881	886	890
31	895	900	904	909	914	918	923	928	932	937
32	942	946	951	956	960	965	970	974	979	984
33	988	993	997	*002	*007	*011	*016	*021	*025	*030
34	97 035	039	044	049	053	058	063	067	072	077
35	081	086	090	095	100	104	109	114	118	123
36	128	132	137	142	146	151	155	160	165	169
37	174	179	183	188	192	197	202	206	211	216
38	220	225	230	234	239	243	248	253	257	262
39	267	271	276	280	285	290	294	299	304	308
940	313	317	322	327	331	336	340	345	350	354
41	359	364	368	373	377	382	387	391	396	400
42	405	410	414	419	424	428	433	437	442	447
43	451	456	460	465	470	474	479	483	488	493
44	497	502	506	511	516	520	525	529	534	539
45	543	548	552	557	562	566	571	575	580	585
46	589	594	598	603	607	612	617	621	626	630
47	635	640	644	649	653	658	663	667	672	676
48	681	685	690	695	699	704	708	713	717	722
49	727	731	736	740	745	749	754	759	763	768
950	772	777	782	786	791	795	800	804	809	813
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	5	4
1	0.5	0.4
2	1.0	0.8
3	1.5	1.2
4	2.0	1.6
5	2.5	2.0
6	3.0	2.4
7	3.5	2.8
8	4.0	3.2
9	4.5	3.6

Prop. Pts.

	0	1	2	3	4	5	6	7	8	9
950	97 772	777	782	786	791	795	800	804	809	813
51	818	823	827	832	836	841	845	850	855	859
52	864	868	873	877	882	886	891	896	900	905
53	909	914	918	923	928	932	937	941	946	950
54	955	959	964	968	973	978	982	987	991	996
55	98 000	005	009	014	019	023	028	032	037	041
56	046	050	055	059	064	068	073	078	082	087
57	091	096	100	105	109	114	118	123	127	132
58	137	141	146	150	155	159	164	168	173	177
59	182	186	191	195	200	204	209	214	218	223
960	227	232	236	241	245	250	254	259	263	268
61	272	277	281	286	290	295	299	304	308	313
62	318	322	327	331	336	340	345	349	354	358
63	363	367	372	376	381	385	390	394	399	403
64	408	412	417	421	426	430	435	439	444	448
65	453	457	462	466	471	475	480	484	489	493
66	498	502	507	511	516	520	525	529	534	538
67	543	547	552	556	561	565	570	574	579	583
68	588	592	597	601	605	610	614	619	623	628
69	632	637	641	646	650	655	659	664	668	673
970	677	682	686	691	695	700	704	709	713	717
71	722	726	731	735	740	744	749	753	758	762
72	767	771	776	780	784	789	793	798	802	807
73	811	816	820	825	829	834	838	843	847	851
74	856	860	865	869	874	878	883	887	892	896
75	900	905	909	914	918	923	927	932	936	941
76	945	949	954	958	963	967	972	976	981	985
77	989	994	998	*003	*007	*012	*016	*021	*025	*029
78	99 034	038	043	047	052	056	061	065	069	074
79	078	083	087	092	096	100	105	109	114	118
980	123	127	131	136	140	145	149	154	158	162
81	167	171	176	180	185	189	193	198	202	207
82	211	216	220	224	229	233	238	242	247	251
83	255	260	264	269	273	277	282	286	291	295
84	300	304	308	313	317	322	326	330	335	339
85	344	348	352	357	361	366	370	374	379	383
86	388	392	396	401	405	410	414	419	423	427
87	432	436	441	445	449	454	458	463	467	471
88	476	480	484	489	493	498	502	506	511	515
89	520	524	528	533	537	542	546	550	555	559
990	564	568	572	577	581	585	590	594	599	603
91	607	612	616	621	625	629	634	638	642	647
92	651	656	660	664	669	673	677	682	686	691
93	695	699	704	708	712	717	721	726	730	734
94	739	743	747	752	756	760	765	769	774	778
95	782	787	791	795	800	804	808	813	817	822
96	826	830	835	839	843	848	852	856	861	865
97	870	874	878	883	887	891	896	900	904	909
98	913	917	922	926	930	935	939	944	948	952
99	957	961	965	970	974	978	983	987	991	996
1000	00 000	004	009	013	017	022	026	030	035	039
	0	1	2	3	4	5	6	7	8	9

Prop. Pts.

	5	4
1	0.5	0.4
2	1.0	0.8
3	1.5	1.2
4	2.0	1.6
5	2.5	2.0
6	3.0	2.4
7	3.5	2.8
8	4.0	3.2
9	4.5	3.6

Prop. Pts.

0° (180°) (359°) 179°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	—	0.00 000	—	—	0.00 000	—	**60**
1	6.46 373	.00 000	6.46 373	3.53 627	.00 000	3.53 627	59
2	6.76 476	.00 000	6.76 476	3.23 524	.00 000	.23 524	58
3	6.94 085	.00 000	6.94 085	3.05 915	.00 000	.05 915	57
4	7.06 579	.00 000	7.06 579	2.93 421	.00 000	2.93 421	56
5	7.16 270	0.00 000	7.16 270	2.83 730	0.00 000	2.83 730	**55**
6	.24 188	.00 000	.24 188	.75 812	.00 000	.75 812	54
7	.30 882	.00 000	.30 882	.69 118	.00 000	.69 118	53
8	.36 682	.00 000	.36 682	.63 318	.00 000	.63 318	52
9	.41 797	.00 000	.41 797	.58 203	.00 000	.58 203	51
10	7.46 373	0.00 000	7.46 373	2.53 627	0.00 000	2.53 627	**50**
11	.50 512	.00 000	.50 512	.49 488	.00 000	.49 488	49
12	.54 291	.00 000	.54 291	.45 709	.00 000	.45 709	48
13	.57 767	.00 000	.57 767	.42 233	.00 000	.42 233	47
14	.60 985	.00 000	.60 986	.39 014	.00 000	.39 015	46
15	7.63 982	0.00 000	7.63 982	2.36 018	0.00 000	2.36 018	**45**
16	.66 784	.00 000	.66 785	.33 215	.00 000	.33 216	44
17	.69 417	9.99 999	.69 418	.30 582	.00 001	.30 583	43
18	.71 900	.99 999	.71 900	.28 100	.00 001	.28 100	42
19	.74 248	.99 999	.74 248	.25 752	.00 001	.25 752	41
20	7.76 475	9.99 999	7.76 476	2.23 524	0.00 001	2.23 525	**40**
21	.78 594	.99 999	.78 595	.21 405	.00 001	.21 406	39
22	.80 615	.99 999	.80 615	.19 385	.00 001	.19 385	38
23	.82 545	.99 999	.82 546	.17 454	.00 001	.17 455	37
24	.84 393	.99 999	.84 394	.15 606	.00 001	.15 607	36
25	7.86 166	9.99 999	7.86 167	2.13 833	0.00 001	2.13 834	**35**
26	.87 870	.99 999	.87 871	.12 129	.00 001	.12 130	34
27	.89 509	.99 999	.89 510	.10 490	.00 001	.10 491	33
28	.91 088	.99 999	.91 089	.08 911	.00 001	.08 912	32
29	.92 612	.99 998	.92 613	.07 387	.00 002	.07 388	31
30	7.94 084	9.99 998	7.94 086	2.05 914	0.00 002	2.05 916	**30**
31	.95 508	.99 998	.95 510	.04 490	.00 002	.04 492	29
32	.96 887	.99 998	.96 889	.03 111	.00 002	.03 113	28
33	.98 223	.99 998	.98 225	.01 775	.00 002	.01 777	27
34	.99 520	.99 998	.99 522	.00 478	.00 002	.00 480	26
35	8.00 779	9.99 998	8.00 781	1.99 219	0.00 002	1.99 221	**25**
36	.02 002	.99 998	.02 004	.97 996	.00 002	.97 998	24
37	.03 192	.99 997	.03 194	.96 806	.00 003	.96 808	23
38	.04 350	.99 997	.04 353	.95 647	.00 003	.95 650	22
39	.05 478	.99 997	.05 481	.94 519	.00 003	.94 522	21
40	8.06 578	9.99 997	8.06 581	1.93 419	0.00 003	1.93 422	**20**
41	.07 650	.99 997	.07 653	.92 347	.00 003	.92 350	19
42	.08 696	.99 997	.08 700	.91 300	.00 003	.91 304	18
43	.09 718	.99 997	.09 722	.90 278	.00 003	.90 282	17
44	.10 717	.99 996	.10 720	.89 280	.00 004	.89 283	16
45	8.11 693	9.99 996	8.11 696	1.88 304	0.00 004	1.88 307	**15**
46	.12 647	.99 996	.12 651	.87 349	.00 004	.87 353	14
47	.13 581	.99 996	.13 585	.86 415	.00 004	.86 419	13
48	.14 495	.99 996	.14 500	.85 500	.00 004	.85 505	12
49	.15 391	.99 996	.15 395	.84 605	.00 004	.84 609	11
50	8.16 268	9.99 995	8.16 273	1.83 727	0.00 005	1.83 732	**10**
51	.17 128	.99 995	.17 133	.82 867	.00 005	.82 872	9
52	.17 971	.99 995	.17 976	.82 024	.00 005	.82 029	8
53	.18 798	.99 995	.18 804	.81 196	.00 005	.81 202	7
54	.19 610	.99 995	.19 616	.80 384	.00 005	.80 390	6
55	8.20 407	9.99 994	8.20 413	1.79 587	0.00 006	1.79 593	**5**
56	.21 189	.99 994	.21 195	.78 805	.00 006	.78 811	4
57	.21 958	.99 994	.21 964	.78 036	.00 006	.78 042	3
58	.22 713	.99 994	.22 720	.77 280	.00 006	.77 287	2
59	.23 456	.99 994	.23 462	.76 538	.00 006	.76 544	1
60	8.24 186	9.99 993	8.24 192	1.75 808	0.00 007	1.75 814	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

90° (270°) (269°) 89°

1° (181°) (358°) 178°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	8.24 186	9.99 993	8.24 192	1.75 808	0.00 007	1.75 814	**60**
1	.24 903	.99 993	.24 910	.75 090	.00 007	.75 097	59
2	.25 609	.99 993	.25 616	.74 384	.00 007	.74 391	58
3	.26 304	.99 993	.26 312	.73 688	.00 007	.73 696	57
4	.26 988	.99 992	.26 996	.73 004	.00 008	.73 012	56
5	8.27 661	9.99 992	8.27 669	1.72 331	0.00 008	1.72 339	**55**
6	.28 324	.99 992	.28 332	.71 668	.00 008	.71 676	54
7	.28 977	.99 992	.28 986	.71 014	.00 008	.71 023	53
8	.29 621	.99 992	.29 629	.70 371	.00 008	.70 379	52
9	.30 255	.99 991	.30 263	.69 737	.00 009	.69 745	51
10	8.30 879	9.99 991	8.30 888	1.69 112	0.00 009	1.69 121	**50**
11	.31 495	.99 991	.31 505	.68 495	.00 009	.68 505	49
12	.32 103	.99 990	.32 112	.67 888	.00 010	.67 897	48
13	.32 702	.99 990	.32 711	.67 289	.00 010	.67 298	47
14	.33 292	.99 990	.33 302	.66 698	.00 010	.66 708	46
15	8.33 875	9.99 990	8.33 886	1.66 114	0.00 010	1.66 125	**45**
16	.34 450	.99 989	.34 461	.65 539	00.011	65 550	44
17	.35 018	.99 989	.35 029	.64 971	.00 011	.64 982	43
18	.35 578	.99 989	.35 590	.64 410	.00 011	.64 422	42
19	.36 131	.99 989	.36 143	.63 857	.00 011	.63 869	41
20	8.36 678	9.99 988	8.36 689	1.63 311	0.00 012	1.63 322	**40**
21	.37 217	.99 988	.37 229	.62 771	.00 012	.62 783	39
22	.37 750	.99 988	.37 762	.62 238	.00 012	.62 250	38
23	.38 276	.99 987	.38 289	.61 711	.00 013	.61 724	37
24	.38 796	.99 987	.38 809	.61 191	.00 013	.61 204	36
25	8.39 310	9.99 987	8.39 323	1.60 677	0.00 013	1.60 690	**35**
26	.39 818	.99 986	.39 832	.60 168	.00 014	.60 182	34
27	.40 320	.99 986	.40 334	.59 666	.00 014	.59 680	33
28	.40 816	.99 986	.40 830	.59 170	.00 014	.59 184	32
29	.41 307	.99 985	.41 321	.58 679	.00 015	.58 693	31
30	8.41 792	9.99 985	8.41 807	1.58 193	0.00 015	1.58 208	**30**
31	.42 272	.99 985	.42 287	.57 713	.00 015	.57 728	29
32	.42 746	.99 984	.42 762	.57 238	.00 016	.57 254	28
33	.43 216	.99 984	.43 232	.56 768	.00 016	.56 784	27
34	.43 680	.99 984	.43 696	.56 304	.00 016	.56 320	26
35	8.44 139	9.99 983	8.44 156	1.55 844	0.00 017	1.55 861	**25**
36	.44 594	.99 983	.44 611	.55 389	.00 017	.55 406	24
37	.45 044	.99 983	.45 061	.54 939	.00 017	.54 956	23
38	.45 489	.99 982	.45 507	.54 493	.00 018	.54 511	22
39	.45 930	.99 982	.45 948	.54 052	.00 018	.54 070	21
40	8.46 366	9.99 982	8.46 385	1.53 615	0.00 018	1.53 634	**20**
41	.46 799	.99 981	.46 817	.53 183	.00 019	.53 201	19
42	.47 226	.99 981	.47 245	.52 755	.00 019	.52 774	18
43	.47 650	.99 981	.47 669	.52 331	.00 019	.52 350	17
44	.48 069	.99 980	.48 089	.51 911	.00 020	.51 931	16
45	8.48 485	9.99 980	8.48 505	1.51 495	0.00 020	1.51 515	**15**
46	.48 896	.99 979	.48 917	.51 083	.00 021	.51 104	14
47	.49 304	.99 979	.49 325	.50 675	.00 021	.50 696	13
48	.49 708	.99 979	.49 729	.50 271	.00 021	.50 292	12
49	.50 108	.99 978	.50 130	.49 870	.00 022	.49 892	11
50	8.50 504	9.99 978	8.50 527	1.49 473	0.00 022	1.49 496	**10**
51	.50 897	.99 977	.50 920	.49 080	.00 023	.49 103	9
52	.51 287	.99 977	.51 310	.48 690	.00 023	.48 713	8
53	.51 673	.99 977	.51 696	.48 304	.00 023	.48 327	7
54	.52 055	.99 976	.52 079	.47 921	.00 024	.47 945	6
55	8.52 434	9.99 976	8.52 459	1.47 541	0.00 024	1.47 566	**5**
56	.52 810	.99 975	.52 835	.47 165	.00 025	.47 190	4
57	.53 183	.99 975	.53 208	.46 792	.00 025	.46 817	3
58	.53 552	.99 974	.53 578	.46 422	.00 026	.46 448	2
59	.53 919	.99 974	.53 945	.46 055	.00 026	.46 081	1
60	8.54 282	9.99 974	8.54 308	1.45 692	0.00 026	1.45 718	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

91° (271°) (268°) 88°

2° (182°) (357°) **177°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	8.54 282	9.99 974	8.54 308	1.45 692	0.00 026	1.45 718	**60**
1	.54 642	.99 973	.54 669	.45 331	.00 027	.45 358	59
2	.54 999	.99 973	.55 027	.44 973	.00 027	.45 001	58
3	.55 354	.99 972	.55 382	.44 618	.00 028	.44 646	57
4	.55 705	.99 972	.55 734	.44 266	.00 028	.44 295	56
5	8.56 054	9.99 971	8.56 083	1.43 917	0.00 029	1.43 946	**55**
6	.56 400	.99 971	.56 429	.43 571	.00 029	.43 600	54
7	.56 743	.99 970	.56 773	.43 227	.00 030	.43 257	53
8	.57 084	.99 970	.57 114	.42 886	.00 030	.42 916	52
9	.57 421	.99 969	.57 452	.42 548	.00 031	.42 579	51
10	8.57 757	9.99 969	8.57 788	1.42 212	0.00 031	1.42 243	**50**
11	.58 089	.99 968	.58 121	.41 879	.00 032	.41 911	49
12	.58 419	.99 968	.58 451	.41 549	.00 032	.41 581	48
13	.58 747	.99 967	.58 779	.41 221	.00 033	.41 253	47
14	.59 072	.99 967	.59 105	.40 895	.00 033	.40 928	46
15	8.59 395	9.99 967	8.59 428	1.40 572	0.00 033	1.40 605	**45**
16	.59 715	.99 966	.59 749	.40 251	.00 034	.40 285	44
17	.60 033	.99 966	.60 068	.39 932	.00 034	.39 967	43
18	.60 349	.99 965	.60 384	.39 616	.00 035	.39 651	42
19	.60 662	.99 964	.60 698	.39 302	.00 036	.39 338	41
20	8.60 973	9.99 964	8.61 009	1.38 991	0.00 036	1.39 027	**40**
21	.61 282	.99 963	.61 319	.38 681	.00 037	.38 718	39
22	.61 589	.99 963	.61 626	.38 374	.00 037	.38 411	38
23	.61 894	.99 962	.61 931	.38 069	.00 038	.38 106	37
24	.62 196	.99 962	.62 234	.37 766	.00 038	.37 804	36
25	8.62 497	9.99 961	8.62 535	1.37 465	0.00 039	1.37 503	**35**
26	.62 795	.99 961	.62 834	.37 166	.00 039	.37 205	34
27	.63 091	.99 960	.63 131	.36 869	.00 940	.36 909	33
28	.63 385	.99 960	.63 426	.36 574	.00 040	.36 615	32
29	.63 678	.99 959	.63 718	.36 282	.00 041	.36 322	31
30	8.63 968	9.99 959	8.64 009	1.35 991	0.00 041	1.36 032	**30**
31	.64 256	.99 958	.64 298	.35 702	.00 042	.35 744	29
32	.64 543	.99 958	.64 585	.35 415	.00 042	.35 457	28
33	.64 827	.99 957	.64 870	.35 130	.00 043	.35 173	27
34	.65 110	.99 956	.65 154	.34 846	.00 044	.34 890	26
35	8.65 391	9.99 956	8.65 435	1.34 565	0.00 044	1.34 609	**25**
36	.65 670	.99 955	.65 715	.34 285	.00 045	.34 330	24
37	.65 947	.99 955	.65 993	.34 007	.00 045	.34 053	23
38	.66 223	.99 954	.66 269	.33 731	.00 046	.33 777	22
39	.66 497	.99 954	.66 543	.33 457	.00 046	.33 503	21
40	8.66 769	9.99 953	8.66 816	1.33 184	0.00 047	1.33 231	**20**
41	.67 039	.99 952	.67 087	.32 913	.00 048	.32 961	19
42	.67 308	.99 952	.67 356	.32 644	.00 048	.32 692	18
43	.67 575	.99 951	.67 624	.32 376	.00 049	.32 425	17
44	.67 841	.99 951	.67 890	.32 110	.00 049	.32 159	16
45	8.68 104	9.99 950	8.68 154	1.31 846	0.00 050	1.31 896	**15**
46	.68 367	.99 949	.68 417	.31 583	.00 051	.31 633	14
47	.68 627	.99 949	.68 678	.31 322	.00 051	.31 373	13
48	.68 886	.99 948	.68 938	.31 062	.00 052	.31 114	12
49	.69 144	.99 948	.69 196	.30 804	.00 052	.30 856	11
50	8.69 400	9.99 947	8.69 453	1.30 547	0.00 053	1.30 600	**10**
51	.69 654	.99 946	.69 708	.30 292	.00 054	.30 346	9
52	.69 907	.99 946	.69 962	.30 038	.00 054	.30 093	8
53	.70 159	.99 945	.70 214	.29 786	.00 055	.29 841	7
54	.70 409	.99 944	.70 465	.29 535	.00 056	.29 591	6
55	8.70 658	9.99 944	8.70 714	1.29 286	0.00 056	1.29 342	**5**
56	.70 905	.99 943	.70 962	.29 038	.00 057	.29 095	4
57	.71 151	.99 942	.71 208	.28 792	.00 058	.28 849	3
58	.71 395	.99 942	.71 453	.28 547	.00 058	.28 605	2
59	.71 638	.99 941	.71 697	.28 303	.00 059	.28 362	1
60	8.71 880	9.99 940	8.71 940	1.28 060	0.00 060	1.28 120	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

92° (272°) (267°) **87°**

3° (183°) (356°) 176°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	8.71 880	9.99 940	8.71 940	1.28 060	0.00 060	1.28 120	**60**
1	.72 120	.99 940	.72 181	.27 819	.00 060	.27 880	59
2	.72 359	.99 939	.72 420	.27 580	.00 061	.27 641	58
3	.72 597	.99 938	.72 659	.27 341	.00 062	.27 403	57
4	.72 834	.99 938	.72 896	.27 104	.00 062	.27 166	56
5	8.73 069	9.99 937	8.73 132	1.26 868	0.00 063	1.26 931	**55**
6	.73 303	.99 936	.73 366	.26 634	.00 064	.26 697	54
7	.73 535	.99 936	.73 600	.26 400	.00 064	.26 465	53
8	.73 767	.99 935	.73 832	.26 168	.00 065	.26 233	52
9	.73 997	.99 934	.74 063	.25 937	.00 066	.26 003	51
10	8.74 226	9.99 934	8.74 292	1.25 708	0.00 066	1.25 774	**50**
11	.74 454	.99 933	.74 521	.25 479	.00 067	.25 546	49
12	.74 680	.99 932	.74 748	.25 252	.00 068	.25 320	48
13	.74 906	.99 932	.74 974	.25 026	.00 068	.25 094	47
14	.75 130	.99 931	.75 199	.24 801	.00 069	.24 870	46
15	8.75 353	9.99 930	8.75 423	1.24 577	0.00 070	1.24 647	**45**
16	.75 575	.99 929	.75 645	.24 355	.00 071	.24 425	44
17	.75 795	.99 929	.75 867	.24 133	.00 071	.24 205	43
18	.76 015	.99 928	.76 087	.23 913	.00 072	.23 985	42
19	.76 234	.99 927	.76 306	.23 694	.00 073	.23 766	41
20	8.76 451	9.99 926	8.76 525	1.23 475	0.00 074	1.23 549	**40**
21	.76 667	.99 926	.76 742	.23 258	.00 074	.23 333	39
22	.76 883	.99 925	.76 958	.23 042	.00 075	.23 117	38
23	.77 097	.99 924	.77 173	.22 827	.00 076	.22 903	37
24	.77 310	.99 923	.77 387	.22 613	.00 077	.22 690	36
25	8.77 522	9.99 923	8.77 600	1.22 400	0.00 077	1.22 478	**35**
26	.77 733	.99 922	.77 811	.22 189	.00 078	.22 267	34
27	.77 943	.99 921	.78 022	.21 978	.00 079	.22 057	33
28	.78 152	.99 920	.78 232	.21 768	.00 080	.21 848	32
29	.78 360	.99 920	.78 441	.21 559	.00 080	.21 640	31
30	8.78 568	9.99 919	8.78 649	1.21 351	0.00 081	1.21 432	**30**
31	.78 774	.99 918	.78 855	.21 145	.00 082	.21 226	29
32	.78 979	.99 917	.79 061	.20 939	.00 083	.21 021	28
33	.79 183	.99 917	.79 266	.20 734	.00 083	.20 817	27
34	.79 386	.99 916	.79 470	.20 530	.00 084	.20 614	26
35	8.79 588	9.99 915	8.79 673	1.20 327	0.00 085	1.20 412	**25**
36	.79 789	.99 914	.79 875	.20 125	.00 086	.20 211	24
37	.79 990	.99 913	.80 076	.19 924	.00 087	.20 010	23
38	.80 189	.99 913	.80 277	.19 723	.00 087	.19 811	22
39	.80 388	.99 912	.80 476	.19 524	.00 088	.19 612	21
40	8.80 585	9.99 911	8.80 674	1.19 326	0.00 089	1.19 415	**20**
41	.80 782	.99 910	.80 872	.19 128	.00 090	.19 218	19
42	.80 978	.99 909	.81 068	.18 932	.00 091	.19 022	18
43	.81 173	.99 909	.81 264	.18 736	.00 091	.18 827	17
44	.81 367	.99 908	.81 459	.18 541	.00 092	.18 633	16
45	8.81 560	9.99 907	8.81 653	1.18 347	0.00 093	1.18 440	**15**
46	.81 752	.99 906	.81 846	.18 154	.00 094	.18 248	14
47	.81 944	.99 905	.82 038	.17 962	.00 095	.18 056	13
48	.82 134	.99 904	.82 230	.17 770	.00 096	.17 866	12
49	.82 324	.99 904	.82 420	.17 580	.00 096	.17 676	11
50	8.82 513	9.99 903	8.82 610	1.17 390	0.00 097	1.17 487	**10**
51	.82 701	.99 902	.82 799	.17 201	.00 098	.17 299	9
52	.82 888	.99 901	.82 987	.17 013	.00 099	.17 112	8
53	.83 075	.99 900	.83 175	.16 825	.00 100	.16 925	7
54	.83 261	.99 899	.83 361	.16 639	.00 101	.16 739	6
55	8.83 446	9.99 898	8.83 547	1.16 453	0.00 102	1.16 554	**5**
56	.83 630	.99 898	.83 732	.16 268	.00 102	.16 370	4
57	.83 813	.99 897	.83 916	.16 084	.00 103	.16 187	3
58	.83 996	.99 896	.84 100	.15 900	.00 104	.16 004	2
59	.84 177	.99 895	.84 282	.15 718	.00 105	.15 823	1
60	8.84 358	9.99 894	8.84 464	1.15 536	0.00 106	1.15 642	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

93° (273°) (266°) 86°

4° (184°) (355°) 175°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	8.84 358	9.99 894	8.84 464	1.15 536	0.00 106	1.15 642	**60**
1	.84 539	.99 893	.84 646	.15 354	.00 107	.15 461	59
2	.84 718	.99 892	.84 826	.15 174	.00 108	.15 282	58
3	.84 897	.99 891	.85 006	.14 994	.00 109	.15 103	57
4	.85 075	.99 891	.85 185	.14 815	.00 109	.14 925	56
5	8.85 252	9.99 890	8.85 363	1.14 637	0.00 110	1.14 748	**55**
6	.85 429	.99 889	.85 540	.14 460	.00 111	.14 571	54
7	.85 605	.99 888	.85 717	.14 283	.00 112	.14 395	53
8	.85 780	.99 887	.85 893	.14 107	.00 113	.14 220	52
9	.85 955	.99 886	.86 069	.13 931	.00 114	.14 045	51
10	8.86 128	9.99 885	8.86 243	1.13 757	0.00 115	1.13 872	**50**
11	.86 301	.99 884	.86 417	.13 583	.00 116	.13 699	49
12	.86 474	.99 883	.86 591	.13 409	.00 117	.13 526	48
13	.86 645	.99 882	.86 763	.13 237	.00 118	.13 355	47
14	.86 816	.99 881	.86 935	.13 065	.00 119	.13 184	46
15	8.86 987	9.99 880	8.87 106	1.12 894	0.00 120	1.13 013	**45**
16	.87 156	.99 879	.87 277	.12 723	.00 121	.12 844	44
17	.87 325	.99 879	.87 447	.12 553	.00 121	.12 675	43
18	.87 494	.99 878	.87 616	.12 384	.00 122	.12 506	42
19	.87 661	.99 877	.87 785	.12 215	.00 123	.12 339	41
20	8.87 829	9.99 876	8.87 953	1.12 047	0.00 124	1.12 171	**40**
21	.87 995	.99 875	.88 120	.11 880	.00 125	.12 005	39
22	.88 161	.99 874	.88 287	.11 713	00 126	.11 839	38
23	.88 326	.99 873	.88 453	.11 547	.00 127	.11 674	37
24	.88 490	.99 872	.88 618	.11 382	.00 128	.11 510	36
25	8.88 654	9.99 871	8.88 783	1.11 217	0.00 129	1.11 346	**35**
26	.88 817	.99 870	.88 948	.11 052	.00 130	.11 183	34
27	.88 980	.99 869	.89 111	.10 889	.00 131	.11 020	33
28	.89 142	.99 868	.89 274	.10 726	.00 132	.10 858	32
29	.89 304	.99 867	.89 437	.10 563	.00 133	.10 696	31
30	8.89 464	9.99 866	8.89 598	1.10 402	0.00 134	1.10 536	**30**
31	.89 625	.99 865	.89 760	.10 240	.00 135	.10 375	29
32	.89 784	.99 864	.89 920	.10 080	.00 136	.10 216	28
33	.89 943	.99 863	.90 080	.09 920	.00 137	.10 057	27
34	.90 102	.99 862	.90 240	.09 760	.00 138	.09 898	26
35	8.90 260	9.99 861	8.90 399	1.09 601	0.00 139	1.09 740	**25**
36	.90 417	.99 860	.90 557	.09 443	.00 140	.09 583	24
37	.90 574	.99 859	.90 715	.09 285	.00 141	.09 426	23
38	.90 730	.99 858	.90 872	.09 128	.00 142	.09 270	22
39	.90 885	.99 857	.91 029	.08 971	.00 143	.09 115	21
40	8.91 040	9.99 856	8.91 185	1.08 815	0.00 144	1.08 960	**20**
41	.91 195	.99 855	.91 340	.08 660	.00 145	.08 805	19
42	.91 349	.99 854	.91 495	.08 505	.00 146	.08 651	18
43	.91 502	.99 853	.91 650	.08 350	.00 147	.08 498	17
44	.91 655	.99 852	.91 803	.08 197	.00 148	.08 345	16
45	8.91 807	9.99 851	8.91 957	1.08 043	0.00 149	1.08 193	**15**
46	.91 959	.99 850	.92 110	.07 890	.00 150	.08 041	14
47	.92 110	.99 848	.92 262	.07 738	.00 152	.07 890	13
48	.92 261	.99 847	.92 414	.07 586	.00 153	.07 739	12
49	.92 411	.99 846	.92 565	.07 435	.00 154	.07 589	11
50	8.92 561	9.99 845	8.92 716	1.07 284	0.00 155	1.07 439	**10**
51	.92 710	.99 844	.92 866	.07 134	.00 156	.07 290	9
52	.92 859	.99 843	.93 016	.06 984	.00 157	.07 141	8
53	.93 007	.99 842	.93 165	.06 835	.00 158	.06 993	7
54	.93 154	.99 841	.93 313	.06 687	.00 159	.06 846	6
55	8.93 301	9.99 840	8.93 462	1.06 538	0.00 160	1.06 699	**5**
56	.93 448	.99 839	.93 609	.06 391	.00 161	.06 552	4
57	.93 594	.99 838	.93 756	.06 244	.00 162	.06 406	3
58	.93 740	.99 837	.93 903	.06 097	.00 163	.06 260	2
59	.93 885	.99 836	.94 049	.05 951	.00 164	.06 115	1
60	8.94 030	9.99 834	8.94 195	1.05 805	0.00 166	1.05 970	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

94° (274°) (265°) 85°

5° (185°) (354°) 174°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	8.94 030	9.99 834	8.94 195	1.05 805	0.00 166	1.05 970	**60**
1	.94 174	.99 833	.94 340	.05 660	.00 167	.05 826	59
2	.94 317	.99 832	.94 485	.05 515	.00 168	.05 683	58
3	.94 461	.99 831	.94 630	.05 370	.00 169	.05 539	57
4	.94 603	.99 830	.94 773	.05 227	.00 170	.05 397	56
5	8.94 746	9.99 829	8.94 917	1.05 083	0.00 171	1.05 254	**55**
6	.94 887	.99 828	.95 060	.04 940	.00 172	.05 113	54
7	.95 029	.99 827	.95 202	.04 798	.00 173	.04 971	53
8	.95 170	.99 825	.95 344	.04 656	.00 175	.04 830	52
9	.95 310	.99 824	.95 486	.04 514	.00 176	.04 690	51
10	8.95 450	9.99 823	8.95 627	1.04 373	0.00 177	1.04 550	**50**
11	.95 589	.99 822	.95 767	.04 233	.00 178	.04 411	49
12	.95 728	.99 821	.95 908	.04 092	.00 179	.04 272	48
13	.95 867	.99 820	.96 047	.03 953	.00 180	.04 133	47
14	.96 005	.99 819	.96 187	.03 813	.00 181	.03 995	46
15	8.96 143	9.99 817	8.96 325	1.03 675	0.00 183	1.03 857	**45**
16	.96 280	.99 816	.96 464	.03 536	.00 184	.03 720	44
17	.96 417	.99 815	.96 602	.03 398	.00 185	.03 583	43
18	.96 553	.99 814	.96 739	.03 261	.00 186	.03 447	42
19	.96 689	.99 813	.96 877	.03 123	.00 187	.03 311	41
20	8.96 825	9.99 812	8.97 013	1.02 987	0.00 188	1.03 175	**40**
21	.96 960	.99 810	.97 150	.02 850	.00 190	.03 040	39
22	.97 095	.99 809	.97 285	.02 715	.00 191	.02 905	38
23	.97 229	.99 808	.97 421	.02 579	.00 192	.02 771	37
24	.97 363	.99 807	.97 556	.02 444	.00 193	.02 637	36
25	8.97 496	9.99 806	8.97 691	1.02 309	0.00 194	1.02 504	**35**
26	.97 629	.99 804	.97 825	.02 175	.00 196	.02 371	34
27	.97 762	.99 803	.97 959	.02 041	.00 197	.02 238	33
28	.97 894	.99 802	.98 092	.01 908	.00 198	.02 106	32
29	.98 026	.99 801	.98 225	.01 775	.00 199	.01 974	31
30	8.98 157	9.99 800	8.98 358	1.01 642	0.00 200	1.01 843	**30**
31	.98 288	.99 798	.98 490	.01 510	.00 202	.01 712	29
32	.98 419	.99 797	.98 622	.01 378	.00 203	.01 581	28
33	.98 549	.99 796	.98 753	.01 247	.00 204	.01 451	27
34	.98 679	.99 795	.98 884	.01 116	.00 205	.01 321	26
35	8.98 808	9.99 793	8.99 015	1.00 985	0.00 207	1.01 192	**25**
36	.98 937	.99 792	.99 145	.00 855	.00 208	.01 063	24
37	.99 066	.99 791	.99 275	.00 725	.00 209	.00 934	23
38	.99 194	.99 790	.99 405	.00 595	.00 210	.00 806	22
39	.99 322	.99 788	.99 534	.00 466	.00 212	.00 678	21
40	8.99 450	9.99 787	8.99 662	1.00 338	0.00 213	1.00 550	**20**
41	.99 577	.99 786	.99 791	.00 209	.00 214	.00 423	19
42	.99 704	.99 785	.99 919	.00 081	.00 215	.00 296	18
43	.99 830	.99 783	9.00 046	0.99 954	.00 217	.00 170	17
44	.99 956	.99 782	.00 174	.99 826	.00 218	.00 044	16
45	9.00 082	9.99 781	9.00 301	0.99 699	0.00 219	0.99 918	**15**
46	.00 207	.99 780	.00 427	.99 573	.00 220	.99 793	14
47	.00 332	.99 778	.00 553	.99 447	.00 222	.99 668	13
48	.00 456	.99 777	.00 679	.99 321	.00 223	.99 544	12
49	.00 581	.99 776	.00 805	.99 195	.00 224	.99 419	11
50	9.00 704	9.99 775	9.00 930	0.99 070	0.00 225	0.99 296	**10**
51	.00 828	.99 773	.01 055	.98 945	.00 227	.99 172	9
52	.00 951	.99 772	.01 179	.98 821	.00 228	.99 049	8
53	.01 074	.99 771	.01 303	.98 697	.00 229	.98 926	7
54	.01 196	.99 769	.01 427	.98 573	.00 231	.98 804	6
55	9.01 318	9.99 768	9.01 550	0.98 450	0.00 232	0.98 682	**5**
56	.01 440	.99 767	.01 673	.98 327	.00 233	.98 560	4
57	.01 561	.99 765	.01 796	.98 204	.00 235	.98 439	3
58	.01 682	.99 764	.01 918	.98 082	.00 236	.98 318	2
59	.01 803	.99 763	.02 040	.97 960	.00 237	.98 197	1
60	9.01 923	9.99 761	9.02 162	0.97 838	0.00 239	0.98 077	**0**
	Cos	**Sin**	**Cot**	**Tan**	**Csc**	**Sec**	′

95° (275°) (264°) 84°

6° (186°) (353°) 173°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.01 923	9.99 761	9.02 162	0.97 838	0.00 239	0.98 077	**60**
1	.02 043	.99 760	.02 283	.97 717	00 240	.97 957	59
2	.02 163	.99 759	.02 404	.97 596	.00 241	.97 837	58
3	.02 283	.99 757	.02 525	.97 475	.00 243	.97 717	57
4	.02 402	.99 756	.02 645	.97 355	.00 244	.97 598	56
5	9.02 520	9.99 755	9.02 766	0.97 234	0.00 245	0.97 480	**55**
6	.02 639	.99 753	.02 885	.97 115	.00 247	.97 361	54
7	.02 757	.99 752	.03 005	.96 995	.00 248	.97 243	53
8	.02 874	.99 751	.03 124	.96 876	.00 249	.97 126	52
9	.02 992	.99 749	.03 242	.96 758	.00 251	.97 008	51
10	9.03 109	9.99 748	9.03 361	0.96 639	0.00 252	0.96 891	**50**
11	.03 226	.99 747	.03 479	.96 521	.00 253	.96 774	49
12	.03 342	.99 745	.03 597	.96 403	.00 255	.96 658	48
13	.03 458	.99 744	.03 714	.96 286	.00 256	.96 542	47
14	.03 574	.99 742	.03 832	.96 168	.00 258	.96 426	46
15	9.03 690	9.99 741	9.03 948	0.96 052	0.00 259	0.96 310	**45**
16	.03 805	.99 740	.04 065	.95 935	.00 260	.96 195	44
17	.03 920	.99 738	.04 181	.95 819	.00 262	.96 080	43
18	.04 034	.99 737	.04 297	.95 703	.00 263	.95 966	42
19	.04 149	.99 736	.04 413	.95 587	.00 264	.95 851	41
20	9.04 262	9.99 734	9.04 528	0.95 472	0.00 266	0.95 738	**40**
21	.04 376	.99 733	.04 643	.95 357	.00 267	.95 624	39
22	.04 490	.99 731	.04 758	.95 242	.00 269	.95 510	38
23	.04 603	.99 730	.04 873	.95 127	.00 270	.95 397	37
24	.04 715	.99 728	.04 987	.95 013	.00 272	.95 285	36
25	9.04 828	9.99 727	9.05 101	0.94 899	0.00 273	0.95 172	**35**
26	.04 940	.99 726	.05 214	.94 786	.00 274	.95 060	34
27	.05 052	.99 724	.05 328	.94 672	.00 276	.94 948	33
28	.05 164	.99 723	.05 441	. 94 559	.00 277	.94 836	32
29	.05 275	.99 721	.05 553	.94 447	.00 279	.94 725	31
30	9.05 386	9.99 720	9.05 666	0.94 334	0.00 280	0.94 614	**30**
31	.05 497	.99 718	.05 778	.94 222	.00 282	.94 503	29
32	.05 607	.99 717	.05 890	.94 110	.00 283	.94 393	28
33	.05 717	.99 716	.06 002	.93 998	.00 284	.94 283	27
34	.05 827	.99 714	.06 113	.93 887	.00 286	.94 173	26
35	9.05 937	9.99 713	9.06 224	0.93 776	0.00 287	0.94 063	**25**
36	.06 046	.99 711	.06 335	.93 665	.00 289	.93 954	24
37	.06 155	.99 710	.06 445	.93 555	.00 290	.93 845	23
38	.06 264	.99 708	.06 556	.93 444	.00 292	.93 736	22
39	.06 372	.99 707	.06 666	.93 334	.00 293	.93 628	21
40	9.06 481	9.99 705	9.06 775	0.93 225	0.00 295	0.93 519	**20**
41	.06 589	.99 704	.06 885	.93 115	.00 296	.93 411	19
42	.06 696	.99 702	.06 994	.93 006	.00 298	.93 304	18
43	.06 804	.99 701	.07 103	.92 897	.00 299	.93 196	17
44	.06 911	.99 699	.07 211	.92 789	.00 301	.93 089	16
45	9.07 018	9.99 698	9.07 320	0.92 680	0.00 302	0.92 982	**15**
46	.07 124	.99 696	.07 428	.92 572	.00 304	.92 876	14
47	.07 231	.99 695	.07 536	.92 464	.00 305	.92 769	13
48	.07 337	.99 693	.07 643	.92 357	00.307	.92 663	12
49	.07 442	.99 692	.07 751	.92 249	.00 308	.92 558	11
50	9.07 548	9.99 690	9.07 858	0.92 142	0.00 310	0.92 452	**10**
51	.07 653	.99 689	.07 964	.92 036	.00 311	.92 347	9
52	.07 758	.99 687	.08 071	.91 929	.00 313	.92 242	8
53	.07 863	.99 686	.08 177	.91 823	.00 314	.92 137	7
54	.07 968	.99 684	.08 283	.91 717	.00 316	.92 032	6
55	9.08 072	9.99 683	9.08 389	0.91 611	0.00 317	0.91 928	**5**
56	.08 176	.99 681	.08 495	.91 505	.00 319	.91 824	4
57	.08 280	.99 680	.08 600	.91 400	.00 320	.91 720	3
58	.08 383	.99 678	.08 705	.91 295	.00 322	.91 617	2
59	.08 486	.99 677	.08 810	.91 190	.00 323	.91 514	1
60	9.08 589	9.99 675	9.08 914	0.91 086	0.00 325	0.91 411	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

96° (276°) (263°) 83°

7° (187°) (352°) 172°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.08 589	9.99 675	9.08 914	0.91 086	0.00 325	0.91 411	**60**
1	.08 692	.99 674	.09 019	.90 981	.00 326	.91 308	59
2	.08 795	.99 672	.09 123	.90 877	.00 328	.91 205	58
3	.08 897	.99 670	.09 227	.90 773	.00 330	.91 103	57
4	.08 999	.99 669	.09 330	.90 670	.00 331	.91 001	56
5	9.09 101	9.99 667	9.09 434	0.90 566	0.00 333	0.90 899	**55**
6	.09 202	.99 666	.09 537	.90 463	.00 334	.90 798	54
7	.09 304	.99 664	.09 640	.90 360	.00 336	.90 696	53
8	.09 405	.99 663	.09 742	.90 258	.00 337	.90 595	52
9	.09 506	.99 661	.09 845	.90 155	.00 339	.90 494	51
10	9.09 606	9.99 659	9.09 947	0.90 053	0.00 341	0.90 394	**50**
11	.09 707	.99 658	.10 049	.89 951	.00 342	.90 293	49
12	.09 807	.99 656	.10 150	.89 850	.00 344	.90 193	48
13	.09 907	.99 655	.10 252	.89 748	.00 345	.90 093	47
14	.10 006	.99 653	.10 353	.89 647	.00 347	.89 994	46
15	9.10 106	9.99 651	9.10 454	0.89 546	0.00 349	0.89 894	**45**
16	.10 205	.99 650	.10 555	.89 445	.00 350	.89 795	44
17	.10 304	.99 648	.10 656	.89 344	.00 352	.89 696	43
18	.10 402	.99 647	.10 756	.89 244	.00 353	.89 598	42
19	.10 501	.99 645	.10 856	.89 144	.00 355	.89 499	41
20	9.10 599	9.99 643	9.10 956	0.89 044	0.00 357	0.89 401	**40**
21	.10 697	.99 642	.11 056	.88 944	.00 358	.89 303	39
22	.10 795	.99 640	.11 155	.88 845	.00 360	.89 205	38
23	.10 893	.99 638	.11 254	.88 746	.00 362	.89 107	37
24	.10 990	.99 637	.11 353	.88 647	.00 363	.89 010	36
25	9.11 087	9.99 635	9.11 452	0.88 548	0.00 365	0.88 913	**35**
26	.11 184	.99 633	.11 551	.88 449	.00 367	.88 816	34
27	.11 281	.99 632	.11 649	.88 351	.00 368	.88 719	33
28	.11 377	.99 630	.11 747	.88 253	.00 370	.88 623	32
29	.11 474	.99 629	.11 845	.88 155	.00 371	.88 526	31
30	9.11 570	9.99 627	9.11 943	0.88 057	0.00 373	0.88 430	**30**
31	.11 666	.99 625	.12 040	.87 960	.00 375	.88 334	29
32	.11 761	.99 624	.12 138	.87 862	.00 376	.88 239	28
33	.11 857	.99 622	.12 235	.87 765	.00 378	.88 143	27
34	.11 952	.99 620	.12 332	.87 668	.00 380	.88 048	26
35	9.12 047	9.99 618	9.12 428	0.87 572	0.00 382	0.87 953	**25**
36	.12 142	.99 617	.12 525	.87 475	.00 383	.87 858	24
37	.12 236	.99 615	.12 621	.87 379	.00 385	.87 764	23
38	.12 331	.99 613	.12 717	.87 283	.00 387	.87 669	22
39	.12 425	.99 612	.12 813	.87 187	.00 388	.87 575	21
40	9.12 519	9.99 610	9.12 909	0.87 091	0.00 390	0.87 481	**20**
41	.12 612	.99 608	.13 004	.86 996	.00 392	.87 388	19
42	.12 706	.99 607	.13 099	.86 901	.00 393	.87 294	18
43	.12 799	.99 605	.13 194	.86 806	.00 395	.87 201	17
44	.12 892	.99 603	.13 289	.86 711	.00 397	.87 108	16
45	9.12 985	9.99 601	9.13 384	0.86 616	0.00 399	0.87 015	**15**
46	.13 078	.99 600	.13 478	.86 522	.00 400	.86 922	14
47	.13 171	.99 598	.13 573	.86 427	.00 402	.86 829	13
48	.13 263	.99 596	.13 667	.86 333	.00 404	.86 737	12
49	.13 355	.99 595	.13 761	.86 239	.00 405	.86 645	11
50	9.13 447	9.99 593	9.13 854	0.86 146	0.00 407	0.86 553	**10**
51	.13 539	.99 591	.13 948	.86 052	.00 409	.86 461	9
52	.13 630	.99 589	.14 041	.85 959	.00 411	.86 370	8
53	.13 722	.99 588	.14 134	.85 866	.00 412	.86 278	7
54	.13 813	.99 586	.14 227	.85 773	.00 414	.86 187	6
55	9.13 904	9.99 584	9.14 320	0.85 680	0.00 416	0.86 096	**5**
56	.13 994	.99 582	.14 412	.85 588	.00 418	.86 006	4
57	.14 085	.99 581	.14 504	.85 496	.00 419	.85 915	3
58	.14 175	.99 579	.14 597	.85 403	.00 421	.85 825	2
59	.14 266	.99 577	.14 688	.85 312	.00 423	.85 734	1
60	9.14 356	9.99 575	9.14 780	0.85 220	0.00 425	0.85 644	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

97° (277°) (262°) 82°

8° (188°) (351°) 171°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.14 356	9.99 575	9.14 780	0.85 220	0.00 425	0.85 644	**60**
1	.14 445	.99 574	.14 872	.85 128	.00 426	.85 555	59
2	.14 535	.99 572	.14 963	.85 037	.00 428	.85 465	58
3	.14 624	.99 570	.15 054	.84 946	.00 430	.85 376	57
4	.14 714	.99 568	.15 145	.84 855	.00 432	.85 286	56
5	9.14 803	9.99 566	9.15 236	0.84 764	0.00 434	0.85 197	**55**
6	.14 891	.99 565	.15 327	.84 673	.00 435	.85 109	54
7	.14 980	.99 563	.15 417	.84 583	.00 437	.85 020	53
8	.15 069	.99 561	.15 508	.84 492	.00 439	.84 931	52
9	.15 157	.99 559	.15 598	.84 402	.00 441	.84 843	51
10	9.15 245	9.99 557	9.15 688	0.84 312	0.00 443	0.84 755	**50**
11	.15 333	.99 556	.15 777	.84 223	.00 444	.84 667	49
12	.15 421	.99 554	.15 867	.84 133	.00 446	.84 579	48
13	.15 508	.99 552	.15 956	.84 044	.00 448	.84 492	47
14	.15 596	.99 550	.16 046	.83 954	.00 450	.84 404	46
15	9.15 683	9.99 548	9.16 135	0.83 865	0.00 452	0.84 317	**45**
16	.15 770	.99 546	.16 224	.83 776	.00 454	.84 230	44
17	.15 857	.99 545	.16 312	.83 688	.00 455	.84 143	43
18	.15 944	.99 543	.16 401	.83 599	.00 457	.84 056	42
19	.16 030	.99 541	.16 489	.83 511	.00 459	.83 970	41
20	9.16 116	9.99 539	9.16 577	0.83 423	0.00 461	0.83 884	**40**
21	.16 203	.99 537	.16 665	.83 335	.00 463	.83 797	39
22	.16 289	.99 535	.16 753	.83 247	.00 465	.83 711	38
23	.16 374	.99 533	.16 841	.83 159	.00 467	.83 626	37
24	.16 460	.99 532	.16 928	.83 072	.00 468	.83 540	36
25	9.16 545	9.99 530	9.17 016	0.82 984	0.00 470	0.83 455	**35**
26	.16 631	.99 528	.17 103	.82 897	.00 472	.83 369	34
27	.16 716	.99 526	.17 190	.82 810	.00 474	.83 284	33
28	.16 801	.99 524	.17 277	.82 723	.00 476	.83 199	32
29	.16 886	.99 522	.17 363	.82 637	.00 478	.83 114	31
30	9.16 970	9.99 520	9.17 450	0.82 550	0.00 480	0.83 030	**30**
31	.17 055	.99 518	.17 536	.82 464	.00 482	.82 945	29
32	.17 139	.99 517	.17 622	.82 378	.00 483	.82 861	28
33	.17 223	.99 515	.17 708	.82 292	.00 485	.82 777	27
34	.17 307	.99 513	.17 794	.82 206	.00 487	.82 693	26
35	9.17 391	9.99 511	9.17 880	0.82 120	0.00 489	0.82 609	**25**
36	.17 474	.99 509	.17 965	.82 035	.00 491	.82 526	24
37	.17 558	.99 507	.18 051	.81 949	.00 493	.82 442	23
38	.17 641	.99 505	.18 136	.81 864	.00 495	.82 359	22
39	.17 724	.99 503	.18 221	.81 779	.00 497	.82 276	21
40	9.17 807	9.99 501	9.18 306	0.81 694	0.00 499	0.82 193	**20**
41	.17 890	.99 499	.18 391	.81 609	.00 501	.82 110	19
42	.17 973	.99 497	.18 475	.81 525	.00 503	.82 027	18
43	.18 055	.99 495	.18 560	.81 440	.00 505	.81 945	17
44	.18 137	.99 494	.18 644	.81 356	.00 506	.81 863	16
45	9.18 220	9.99 492	9.18 728	0.81 272	0.00 508	0.81 780	**15**
46	.18 302	.99 490	.18 812	.81 188	.00 510	.81 698	14
47	.18 383	.99 488	.18 896	.81 104	.00 512	.81 617	13
48	.18 465	.99 486	.18 979	.81 021	.00 514	.81 535	12
49	.18 547	.99 484	.19 063	.80 937	.00 516	.81 453	11
50	9.18 628	9.99 482	9.19 146	0.80 854	0.00 518	0.81 372	**10**
51	.18 709	.99 480	.19 229	.80 771	.00 520	.81 291	9
52	.18 790	.99 478	.19 312	.80 688	.00 522	.81 210	8
53	.18 871	.99 476	.19 395	.80 605	.00 524	.81 129	7
54	.18 952	.99 474	.19 478	.80 522	.00 526	.81 048	6
55	9.19 033	9.99 472	9.19 561	0.80 439	0.00 528	0.80 967	**5**
56	.19 113	.99 470	.19 643	.80 357	.00 530	.80 887	4
57	.19 193	.99 468	.19 725	.80 275	.00 532	.80 807	3
58	.19 273	.99 466	.19 807	.80 193	.00 534	.80 727	2
59	.19 353	.99 464	.19 889	.80 111	.00 536	.80 647	1
60	9.19 433	9.99 462	9.19 971	0.80 029	0.00 538	0.80 567	**0**
	Cos	**Sin**	**Cot**	**Tan**	**Csc**	**Sec**	′

98° (278°) (261°) 81°

9° (189°) (350°) **170°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.19 433	9.99 462	9.19 971	0.80 029	0.00 538	0.80 567	**60**
1	.19 513	.99 460	.20 053	.79 947	.00 540	.80 487	59
2	.19 592	.99 458	.20 134	.79 866	.00 542	.80 408	58
3	.19 672	.99 456	.20 216	.79 784	.00 544	.80 328	57
4	.19 751	.99 454	.20 297	.79 703	.00 546	.80 249	56
5	9.19 830	9.99 452	9.20 378	0.79 622	0.00 548	0.80 170	**55**
6	.19 909	.99 450	.20 459	.79 541	.00 550	.80 091	54
7	.19 988	.99 448	.20 540	.79 460	.00 552	.80 012	53
8	.20 067	.99 446	.20 621	.79 379	.00 554	.79 933	52
9	.20 145	.99 444	.20 701	.79 299	.00 556	.79 855	51
10	9.20 223	9.99 442	9.20 782	0.79 218	0.00 558	0.79 777	**50**
11	.20 302	.99 440	.20 862	.79 138	.00 560	.79 698	49
12	.20 380	.99 438	.20 942	.79 058	.00 562	.79 620	48
13	.20 458	.99 436	.21 022	.78 978	.00 564	.79 542	47
14	.20 535	.99 434	.21 102	.78 898	.00 566	.79 465	46
15	9.20 613	9.99 432	9.21 182	0.78 818	0.00 568	0.79 387	**45**
16	.20 691	.99 429	.21 261	.78 739	.00 571	.79 309	44
17	.20 768	.99 427	.21 341	.78 659	.00 573	.79 232	43
18	.20 845	.99 425	.21 420	.78 580	.00 575	.79 155	42
19	.20 922	.99 423	.21 499	.78 501	.00 577	.79 078	41
20	9.20 999	9.99 421	9.21 578	0.78 422	0.00 579	0.79 001	**40**
21	.21 076	.99 419	.21 657	.78 343	.00 581	.78 924	39
22	.21 153	.99 417	.21 736	.78 264	.00 583	.78 847	38
23	.21 229	.99 415	.21 814	.78 186	.00 585	.78 771	37
24	.21 306	.99 413	.21 893	.78 107	.00 587	.78 694	36
25	9.21 382	9.99 411	9.21 971	0.78 029	0.00 589	0.78 618	**35**
26	.21 458	.99 409	.22 049	.77 951	.00 591	.78 542	34
27	.21 534	.99 407	.22 127	.77 873	.00 593	.78 466	33
28	.21 610	.99 404	.22 205	.77 795	.00 596	.78 390	32
29	.21 685	.99 402	.22 283	.77 717	.00 598	.78 315	31
30	9.21 761	9.99 400	9.22 361	0.77 639	0.00 600	0.78 239	**30**
31	.21 836	.99 398	.22 438	.77 562	.00 602	.78 164	29
32	.21 912	.99 396	.22 516	.77 484	.00 604	.78 088	28
33	.21 987	.99 394	.22 593	.77 407	.00 606	.78 013	27
34	.22 062	.99 392	.22 670	.77 330	.00 608	.77 938	26
35	9.22 137	9.99 390	9.22 747	0.77 253	0.00 610	0.77 863	**25**
36	.22 211	.99 388	.22 824	.77 176	.00 612	.77 789	24
37	.22 286	.99 385	.22 901	.77 099	.00 615	.77 714	23
38	.22 361	.99 383	.22 977	.77 023	.00 617	.77 639	22
39	.22 435	.99 381	.23 054	.76 946	.00 619	.77 565	21
40	9.22 509	9.99 379	9.23 130	0.76 870	0.00 621	0.77 491	**20**
41	.22 583	.99 377	.23 206	.76 794	.00 623	.77 417	19
42	.22 657	.99 375	.23 283	.76 717	.00 625	.77 343	18
43	.22 731	.99 372	.23 359	.76 641	.00 628	.77 269	17
44	.22 805	.99 370	.23 435	.76 565	.00 630	.77 195	16
45	9.22 878	9.99 368	9.23 510	0.76 490	0.00 632	0.77 122	**15**
46	.22 952	.99 366	.23 586	.76 414	.00 634	.77 048	14
47	.23 025	.99 364	.23 661	.76 339	.00 636	.76 975	13
48	.23 098	.99 362	.23 737	.76 263	.00 638	.76 902	12
49	.23 171	.99 359	.23 812	.76 188	.00 641	.76 829	11
50	9.23 244	9.99 357	9.23 887	0.76 113	0.00 643	0.76 756	**10**
51	.23 317	.99 355	.23 962	.76 038	.00 645	.76 683	9
52	.23 390	.99 353	.24 037	.75 963	.00 647	.76 610	8
53	.23 462	.99 351	.24 112	.75 888	.00 649	.76 538	7
54	.23 535	.99 348	.24 186	.75 814	.00 652	.76 465	6
55	9.23 607	9.99 346	9.24 261	0.75 739	0.00 654	0.76 393	**5**
56	.23 679	.99 344	.24 335	.75 665	.00 656	.76 321	4
57	.23 752	.99 342	.24 410	.75 590	.00 658	.76 248	3
58	.23 823	.99 340	.24 484	.75 516	.00 660	.76 177	2
59	.23 895	.99 337	.24 558	.75 442	.00 663	.76 105	1
60	9.23 967	9.99 335	9.24 632	0.75 368	0.00 665	0.76 033	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

99° (279°) (260°) **80°**

10° (190°) (349°) **169°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.23 967	9.99 335	9.24 632	0.75 368	0.00 665	0.76 033	60
1	.24 039	.99 333	.24 706	.75 294	.00 667	.75 961	59
2	.24 110	.99 331	.24 779	.75 221	.00 669	.75 890	58
3	.24 181	.99 328	.24 853	.75 147	.00 672	.75 819	57
4	.24 253	.99 326	.24 926	.75 074	.00 674	.75 747	56
5	9.24 324	9.99 324	9.25 000	0.75 000	0.00 676	0.75 676	**55**
6	.24 395	.99 322	.25 073	.74 927	.00 678	.75 605	54
7	.24 466	.99 319	.25 146	.74 854	.00 681	.75 534	53
8	.24 536	.99 317	.25 219	.74 781	.00 683	.75 464	52
9	.24 607	.99 315	.25 292	.74 708	.00 685	.75 393	51
10	9.24 677	9.99 313	9.25 365	0.74 635	0.00 687	0.75 323	**50**
11	.24 748	.99 310	.25 437	.74 563	.00 690	.75 252	49
12	.24 818	.99 308	.25 510	.74 490	.00 692	.75 182	48
13	.24 888	.99 306	.25 582	.74 418	.00 694	.75 112	47
14	.24 958	.99 304	.25 655	.74 345	.00 696	.75 042	46
15	9.25 028	9.99 301	9.25 727	0.74 273	0.00 699	0.74 972	**45**
16	.25 098	.99 299	.25 799	.74 201	.00 701	.74 902	44
17	.25 168	.99 297	.25 871	.74 129	.00 703	.74 832	43
18	.25 237	.99 294	.25 943	.74 057	.00 706	.74 763	42
19	.25 307	.99 292	.26 015	.73 985	.00 708	.74 693	41
20	9.25 376	9.99 290	9.26 086	0.73 914	0.00 710	0.74 624	**40**
21	.25 445	.99 288	.26 158	.73 842	.00 712	.74 555	39
22	.25 514	.99 285	.26 229	.73 771	.00 715	.74 486	38
23	.25 583	.99 283	.26 301	.73 699	.00 717	.74 417	37
24	.25 652	.99 281	.26 372	.73 628	.00 719	.74 348	36
25	9.25 721	9.99 278	9.26 443	0.73 557	0.00 722	0.74 279	**35**
26	.25 790	.99 276	.26 514	.73 486	.00 724	.74 210	34
27	.25 858	.99 274	.26 585	.73 415	.00 726	.74 142	33
28	.25 927	.99 271	.26 655	.73 345	.00 729	.74 073	32
29	.25 995	.99 269	.26 726	.73 274	.00 731	.74 005	31
30	9.26 063	9.99 267	9.26 797	0.73 203	0.00 733	0.73 937	**30**
31	.26 131	.99 264	.26 867	.73 133	.00 736	.73 869	29
32	.26 199	.99 262	.26 937	.73 063	.00 738	.73 801	28
33	.26 267	.99 260	.27 008	.72 992	.00 740	.73 733	27
34	.26 335	.99 257	.27 078	.72 922	.00 743	.73 665	26
35	9.26 403	9.99 255	9.27 148	0.72 852	0.00 745	0.73 597	**25**
36	.26 470	.99 252	.27 218	.72 782	.00 748	.73 530	24
37	.26 538	.99 250	.27 288	.72 712	.00 750	.73 462	23
38	.26 605	.99 248	.27 357	.72 643	.00 752	.73 395	22
39	.26 672	.99 245	.27 427	.72 573	.00 755	.73 328	21
40	9.26 739	9.99 243	9.27 496	0.72 504	0.00 757	0.73 261	**20**
41	.26 806	.99 241	.27 566	.72 434	.00 759	.73 194	19
42	.26 873	.99 238	.27 635	.72 365	.00 762	.73 127	18
43	.26 940	.99 236	.27 704	.72 296	.00 764	.73 060	17
44	.27 007	.99 233	.27 773	.72 227	.00 767	.72 993	16
45	9.27 073	9.99 231	9.27 842	0.72 158	0.00 769	0.72 927	**15**
46	.27 140	.99 229	.27 911	.72 089	.00 771	.72 860	14
47	.27 206	.99 226	.27 980	.72 020	.00 774	.72 794	13
48	.27 273	.99 224	.28 049	.71 951	.00 776	.72 727	12
49	.27 339	.99 221	.28 117	.71 883	.00 779	.72 661	11
50	9.27 405	9.99 219	9.28 186	0.71 814	0.00 781	0.72 595	**10**
51	.27 471	.99 217	.28 254	.71 746	.00 783	.72 529	9
52	.27 537	.99 214	.28 323	.71 677	.00 786	.72 463	8
53	.27 602	.99 212	.28 391	.71 609	.00 788	.72 398	7
54	.27 668	.99 209	.28 459	.71 541	.00 791	.72 332	6
55	9.27 734	9.99 207	9.28 527	0.71 473	0.00 793	0.72 266	**5**
56	.27 799	.99 204	.28 595	.71 405	.00 796	.72 201	4
57	.27 864	.99 202	.28 662	.71 338	.00 798	.72 136	3
58	.27 930	.99 200	.28 730	.71 270	.00 800	.72 070	2
59	.27 995	.99 197	.28 798	.71 202	.00 803	.72 005	1
60	9.28 060	9.99 195	9.28 865	0.71 135	0.00 805	0.71 940	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

100° (280°) (259°) **79°**

11° (191°) (348°) **168°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.28 060	9.99 195	9.28 865	0.71 135	0.00 805	0.71 940	**60**
1	.28 125	.99 192	.28 933	.71 067	.00 808	.71 875	59
2	.28 190	.99 190	.29 000	.71 000	.00 810	.71 810	58
3	.28 254	.99 187	.29 067	.70 933	.00 813	.71 746	57
4	.28 319	.99 185	.29 134	.70 866	.00 815	.71 681	56
5	9.28 384	9.99 182	9.29 201	0.70 799	0.00 818	0.71 616	**55**
6	.28 448	.99 180	.29 268	.70 732	.00 820	.71 552	54
7	.28 512	.99 177	.29 335	.70 665	.00 823	.71 488	53
8	.28 577	.99 175	.29 402	.70 598	.00 825	.71 423	52
9	.28 641	.99 172	.29 468	.70 532	.00 828	.71 359	51
10	9.28 705	9.99 170	9.29 535	0.70 465	0.00 830	0.71 295	**50**
11	.28 769	.99 167	.29 601	.70 399	.00 833	.71 231	49
12	.28 833	.99 165	.29 668	.70 332	.00 835	.71 167	48
13	.28 896	.99 162	.29 734	.70 266	.00 838	.71 104	47
14	.28 960	.99 160	.29 800	.70 200	.00 840	.71 040	46
15	9.29 024	9.99 157	9.29 866	0.70 134	0.00 843	0.70 976	**45**
16	.29 087	.99 155	.29 932	.70 068	.00 845	.70 913	44
17	.29 150	.99 152	.29 998	.70 002	.00 848	.70 850	43
18	.29 214	.99 150	.30 064	.69 936	.00 850	.70 786	42
19	.29 277	.99 147	.30 130	.69 870	.00 853	.70 723	41
20	9.29 340	9.99 145	9.30 195	0.69 805	0.00 855	0.70 660	**40**
21	.29 403	.99 142	.30 261	.69 739	.00 858	.70 597	39
22	.29 466	.99 140	.30 326	.69 674	.00 860	.70 534	38
23	.29 529	.99 137	.30 391	.69 609	.00 863	.70 471	37
24	.29 591	.99 135	.30 457	.69 543	.00 865	.70 409	36
25	9.29 654	9.99 132	9.30 522	0.69 478	0.00 868	0.70 346	**35**
26	.29 716	.99 130	.30 587	.69 413	.00 870	.70 284	34
27	.29 779	.99 127	.30 652	.69 348	.00 873	.70 221	33
28	.29 841	.99 124	.30 717	.69 283	.00 876	.70 159	32
29	.29 903	.99 122	.30 782	.69 218	.00 878	.70 097	31
30	9.29 966	9.99 119	9.30 846	0.69 154	0.00 881	0.70 034	**30**
31	.30 028	.99 117	.30 911	.69 089	.00 883	.69 972	29
32	.30 090	.99 114	.30 975	.69 025	.00 886	.69 910	28
33	.30 151	.99 112	.31 040	.68 960	.00 888	.69 849	27
34	.30 213	.99 109	.31 104	.68 896	.00 891	.69 787	26
35	9.30 275	9.99 106	9.31 168	0.68 832	0.00 894	0.69 725	**25**
36	.30 336	.99 104	.31 233	.68 767	.00 896	.69 664	24
37	.30 398	.99 101	.31 297	.68 703	.00 899	.69 602	23
38	.30 459	.99 099	.31 361	.68 639	.00 901	.69 541	22
39	.30 521	.99 096	.31 425	.68 575	.00 904	.69 479	21
40	9.30 582	9.99 093	9.31 489	0.68 511	0.00 907	0.69 418	**20**
41	.30 643	.99 091	.31 552	.68 448	.00 909	.69 357	19
42	.30 704	.99 088	.31 616	.68 384	.00 912	.69 296	18
43	.30 765	.99 086	.31 679	.68 321	.00 914	.69 235	17
44	.30 826	.99 083	.31 743	.68 257	.00 917	.69 174	16
45	9.30 887	9.99 080	9.31 806	0.68 194	0.00 920	0.69 113	**15**
46	.30 947	.99 078	.31 870	.68 130	.00 922	.69 053	14
47	.31 008	.99 075	.31 933	.68 067	.00 925	.68 992	13
48	.31 068	.99 072	.31 996	.68 004	.00 928	.68 932	12
49	.31 129	.99 070	.32 059	.67 941	.00 930	.68 871	11
50	9.31 189	9.99 067	9.32 122	0.67 878	0.00 933	0.68 811	**10**
51	.31 250	.99 064	.32 185	.67 815	.00 936	.68 750	9
52	.31 310	.99 062	.32 248	.67 752	.00 938	.68 690	8
53	.31 370	.99 059	.32 311	.67 689	.00 941	.68 630	7
54	.31 430	.99 056	.32 373	.67 627	.00 944	.68 570	6
55	9.31 490	9.99 054	9.32 436	0.67 564	0.00 946	0.68 510	**5**
56	.31 549	.99 051	.32 498	.67 502	.00 949	.68 451	4
57	.31 609	.99 048	.32 561	.67 439	.00 952	.68 391	3
58	.31 669	.99 046	.32 623	.67 377	.00 954	.68 331	2
59	.31 728	.99 043	.32 685	.67 315	.00 957	.68 272	1
60	9.31 788	9.99 040	9.32 747	0.67 253	0.00 960	0.68 212	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

101° (281°) (258°) **78°**

12° (192°) (347°) **167°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.31 788	9.99 040	9.32 747	0.67 253	0.00 960	0.68 212	**60**
1	.31 847	.99 038	.32 810	.67 190	.00 962	.68 153	59
2	.31 907	.99 035	.32 872	.67 128	.00 965	.68 093	58
3	.31 966	.99 032	.32 933	.67 067	.00 968	.68 034	57
4	.32 025	.99 030	.32 995	.67 005	.00 970	.67 975	56
5	9.32 084	9.99 027	9.33 057	0.66 943	0.00 973	0.67 916	**55**
6	.32 143	.99 024	.33 119	.66 881	.00 976	.67 857	54
7	.32 202	.99 022	.33 180	.66 820	.00 978	.67 798	53
8	.32 261	.99 019	.33 242	.66 758	.00 981	.67 739	52
9	.32 319	.99 016	.33 303	.66 697	.00 984	.67 681	51
10	9.32 378	9.99 013	9.33 365	0.66 635	0.00 987	0.67 622	**50**
11	.32 437	.99 011	.33 426	.66 574	.00 989	.67 563	49
12	.32 495	.99 008	.33 487	.66 513	.00 992	.67 505	48
13	.32 553	.99 005	.33 548	.66 452	.00 995	.67 447	47
14	.32 612	.99 002	.33 609	.66 391	.00 998	.67 388	46
15	9.32 670	9.99 000	9.33 670	0.66 330	0.01 000	0.67 330	**45**
16	.32 728	.98 997	.33 731	.66 269	.01 003	.67 272	44
17	.32 786	.98 994	.33 792	.66 208	.01 006	.67 214	43
18	.32 844	.98 991	.33 853	.66 147	.01 009	.67 156	42
19	.32 902	.98 989	.33 913	.66 087	.01 011	.67 098	41
20	9.32 960	9.98 986	9.33 974	0.66 026	0.01 014	0.67 040	**40**
21	.33 018	.98 983	.34 034	.65 966	.01 017	.66 982	39
22	.33 075	.98 980	.34 095	.65 905	.01 020	.66 925	38
23	.33 133	.98 978	.34 155	.65 845	.01 022	.66 867	37
24	.33 190	.98 975	.34 215	.65 785	.01 025	.66 810	36
25	9.33 248	9.98 972	9.34 276	0.65 724	0.01 028	0.66 752	**35**
26	.33 305	.98 969	.34 336	.65 664	.01 031	.66 695	34
27	.33 362	.98 967	.34 396	.65 604	.01 033	.66 638	33
28	.33 420	.98 964	.34 456	.65 544	.01 036	.66 580	32
29	.33 477	.98 961	.34 516	.65 484	.01 039	.66 523	31
30	9.33 534	9.98 958	9.34 576	0.65 424	0.01 042	0.66 466	**30**
31	.33 591	.98 955	.34 635	.65 365	.01 045	.66 409	29
32	.33 647	.98 953	.34 695	.65 305	.01 047	.66 353	28
33	.33 704	.98 950	.34 755	.65 245	.01 050	.66 296	27
34	.33 761	.98 947	.34 814	.65 186	.01 053	.66 239	26
35	9.33 818	9.98 944	9.34 874	0.65 126	0.01 056	0.66 182	**25**
36	.33 874	.98 941	.34 933	.65 067	.01 059	.66 126	24
37	.33 931	.98 938	.34 992	.65 008	.01 062	.66 069	23
38	.33 987	.98 936	.35 051	.64 949	.01 064	.66 013	22
39	.34 043	.98 933	.35 111	.64 889	.01 067	.65 957	21
40	9.34 100	9.98 930	9.35 170	0.64 830	0.01 070	0.65 900	**20**
41	.34 156	.98 927	.35 229	.64 771	.01 073	.65 844	19
42	.34 212	.98 924	.35 288	.64 712	.01 076	.65 788	18
43	.34 268	.98 921	.35 347	.64 653	.01 079	.65 732	17
44	.34 324	.98 919	.35 405	.64 595	.01 081	.65 676	16
45	9.34 380	9.98 916	9.35 464	0.64 536	0.01 084	0.65 620	**15**
46	.34 436	.98 913	.35 523	.64 477	.01 087	.65 564	14
47	.34 491	.98 910	.35 581	.64 419	.01 090	.65 509	13
48	.34 547	.98 907	.35 640	.64 360	.01 093	.65 453	12
49	.34 602	.98 904	.35 698	.64 302	.01 096	.65 398	11
50	9.34 658	9.98 901	9.35 757	0.64 243	0.01 099	0.65 342	**10**
51	.34 713	.98 898	.35 815	.64 185	.01 102	.65 287	9
52	.34 769	.98 896	.35 873	.64 127	.01 104	.65 231	8
53	.34 824	.98 893	.35 931	.64 069	.01 107	.65 176	7
54	.34 879	.98 890	.35 989	.64 011	.01 110	.65 121	6
55	9.34 934	9.98 887	9.36 047	0.63 953	0.01 113	0.65 066	**5**
56	.34 989	.98 884	.36 105	.63 895	.01 116	.65 011	4
57	.35 044	.98 881	.36 163	.63 837	.01 119	.64 956	3
58	.35 099	.98 878	.36 221	.63 779	.01 122	.64 901	2
59	.35 154	.98 875	.36 279	.63 721	.01 125	.64 846	1
60	9.35 209	9.98 872	9.36 336	0.63 664	0.01 128	0.64 791	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

102° (282°) (257°) **77°**

13° (193°) (346°) 166°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.35 209	9.98 872	9.36 336	0.63 664	0.01 128	0.64 791	**60**
1	.35 263	.98 869	.36 394	.63 606	.01 131	.64 737	59
2	.35 318	.98 867	.36 452	.63 548	.01 133	.64 682	58
3	.35 373	.98 864	.36 509	.63 491	.01 136	.64 627	57
4	.35 427	.98 861	.36 566	.63 434	.01 139	.64 573	56
5	9.35 481	9.98 858	9.36 624	0.63 376	0.01 142	0.64 519	**55**
6	.35 536	.98 855	.36 681	.63 319	.01 145	.64 464	54
7	.35 590	.98 852	.36 738	.63 262	.01 148	.64 410	53
8	.35 644	.98 849	.36 795	.63 205	.01 151	.64 356	52
9	.35 698	.98 846	.36 852	.63 148	.01 154	.64 302	51
10	9.35 752	9.98 843	9.36 909	0.63 091	0.01 157	0.64 248	**50**
11	.35 806	.98 840	.36 966	.63 034	.01 160	.64 194	49
12	.35 860	.98 837	.37 023	.62 977	.01 163	.64 140	48
13	.35 914	.98 834	.37 080	.62 920	.01 166	.64 086	47
14	.35 968	.98 831	.37 137	.62 863	.01 169	.64 032	46
15	9.36 022	9.98 828	9.37 193	0.62 807	0.01 172	0.63 978	**45**
16	.36 075	.98 825	.37 250	.62 750	.01 175	.63 925	44
17	.36 129	.98 822	.37 306	.62 694	.01 178	.63 871	43
18	.36 182	.98 819	.37 363	.62 637	.01 181	.63 818	42
19	.36 236	.98 816	.37 419	.62 581	.01 184	.63 764	41
20	9.36 289	9.98 813	9.37 476	0.62 524	0.01 187	0.63 711	**40**
21	.36 342	.98 810	.37 532	.62 468	.01 190	.63 658	39
22	.36 395	.98 807	.37 588	.62 412	.01 193	.63 605	38
23	.36 449	.98 804	.37 644	.62 356	.01 196	.63 551	37
24	.36 502	.98 801	.37 700	.62 300	.01 199	.63 498	36
25	9.36 555	9.98 798	9.37 756	0.62 244	0.01 202	0.63 445	**35**
26	.36 608	.98 795	.37 812	.62 188	.01 205	.63 392	34
27	.36 660	.98 792	.37 868	.62 132	.01 208	.63 340	33
28	.36 713	.98 789	.37 924	.62 076	.01 211	.63 287	32
29	.36 766	.98 786	.37 980	.62 020	.01 214	.63 234	31
30	9.36 819	9.98 783	9.38 035	0.61 965	0.01 217	0.63 181	**30**
31	.36 871	.98 780	.38 091	.61 909	.01 220	.63 129	29
32	.36 924	.98 777	.38 147	.61 853	.01 223	.63 076	28
33	.36 976	.98 774	.38 202	.61 798	.01 226	.63 024	27
34	.37 028	.98 771	.38 257	.61 743	.01 229	.62 972	26
35	9.37 081	9.98 768	9.38 313	0.61 687	0.01 232	0.62 919	**25**
36	.37 133	.98 765	.38 368	.61 632	.01 235	.62 867	24
37	.37 185	.98 762	.38 423	.61 577	.01 238	.62 815	23
38	.37 237	.98 759	.38 479	.61 521	.01 241	.62 763	22
39	.37 289	.98 756	.38 534	.61 466	.01 244	.62 711	21
40	9.37 341	9.98 753	9.38 589	0.61 411	0.01 247	0.62 659	**20**
41	.37 393	.98 750	.38 644	.61 356	.01 250	.62 607	19
42	.37 445	.98 746	.38 699	.61 301	.01 254	.62 555	18
43	.37 497	.98 743	.38 754	.61 246	.01 257	.62 503	17
44	.37 549	.98 740	.38 808	.61 192	.01 260	.62 451	16
45	9.37 600	9.98 737	9.38 863	0.61 137	0.01 263	0.62 400	**15**
46	.37 652	.98 734	.38 918	.61 082	.01 266	.62 348	14
47	.37 703	.98 731	.38 972	.61 028	.01 269	.62 297	13
48	.37 755	.98 728	.39 027	.60 973	.01 272	.62 245	12
49	.37 806	.98 725	.39 082	.60 918	.01 275	.62 194	11
50	9.37 858	9.98 722	9.39 136	0.60 864	0.01 278	0.62 142	**10**
51	.37 909	.98 719	.39 190	.60 810	.01 281	.62 091	9
52	.37 960	.98 715	.39 245	.60 755	.01 285	.62 040	8
53	.38 011	.98 712	.39 299	.60 701	.01 288	.61 989	7
54	.38 062	.98 709	.39 353	.60 647	.01 291	.61 938	6
55	9.38 113	9.98 706	9.39 407	0.60 593	0.01 294	0.61 887	**5**
56	.38 164	.98 703	.39 461	.60 539	.01 297	.61 836	4
57	.38 215	.98 700	.39 515	.60 485	.01 300	.61 785	3
58	.38 266	.98 697	.39 569	.60 431	.01 303	.61 734	2
59	.38 317	.98 694	.39 623	.60 377	.01 306	.61 683	1
60	9.38 368	9.98 690	9.39 677	0.60 323	0.01 310	0.61 632	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

103° (283°) (256°) 76°

14° (194°) (345°) **165°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.38 368	9.98 690	9.39 677	0.60 323	0.01 310	0.61 632	**60**
1	.38 418	.98 687	.39 731	.60 269	.01 313	.61 582	59
2	.38 469	.98 684	.39 785	.60 215	.01 316	.61 531	58
3	.38 519	.98 681	.39 838	.60 162	.01 319	.61 481	57
4	.38 570	.98 678	.39 892	.60 108	.01 322	.61 430	56
5	9.38 620	9.98 675	9.39 945	0.60 055	0.01 325	0.61 380	**55**
6	.38 670	.98 671	.39 999	.60 001	.01 329	.61 330	54
7	.38 721	.98 668	.40 052	.59 948	.01 332	.61 279	53
8	.38 771	.98 665	.40 106	.59 894	.01 335	.61 229	52
9	.38 821	.98 662	.40 159	.59 841	.01 338	.61 179	51
10	9.38 871	9.98 659	9.40 212	0.59 788	0.01 341	0.61 129	**50**
11	.38 921	.98 656	.40 266	.59 734	.01 344	.61 079	49
12	.38 971	.98 652	.40 319	.59 681	.01 348	.61 029	48
13	.39 021	.98 649	.40 372	.59 628	.01 351	.60 979	47
14	.39 071	.98 646	.40 425	.59 575	.01 354	.60 929	46
15	9.39 121	9.98 643	9.40 478	0.59 522	0.01 357	0.60 879	**45**
16	.39 170	.98 640	.40 531	.59 469	.01 360	.60 830	44
17	.39 220	.98 636	.40 584	.59 416	.01 364	.60 780	43
18	.39 270	.98 633	.40 636	.59 364	.01 367	.60 730	42
19	.39 319	.98 630	.40 689	.59 311	.01 370	.60 681	41
20	9.39 369	9.98 627	9.40 742	0.59 258	0.01 373	0.60 631	**40**
21	.39 418	.98 623	.40 795	.59 205	.01 377	.60 582	39
22	.39 467	.98 620	.40 847	.59 153	.01 380	.60 533	38
23	.39 517	.98 617	.40 900	.59 100	.01 383	.60 483	37
24	.39 566	.98 614	.40 952	.59 048	.01 386	.60 434	36
25	9.39 615	9.98 610	9.41 005	0.58 995	0.01 390	0.60 385	**35**
26	.39 664	.98 607	.41 057	.58 943	.01 393	.60 336	34
27	.39 713	.98 604	.41 109	.58 891	.01 396	.60 287	33
28	.39 762	.98 601	.41 161	.58 839	.01 399	.60 238	32
29	.39 811	.98 597	.41 214	.58 786	.01 403	.60 189	31
30	9.39 860	9.98 594	9.41 266	0.58 734	0.01 406	0.60 140	**30**
31	.39 909	.98 591	.41 318	.58 682	.01 409	.60 091	29
32	.39 958	.98 588	.41 370	.58 630	.01 412	.60 042	28
33	.40 006	.98 584	.41 422	.58 578	.01 416	.59 994	27
34	.40 055	.98 581	.41 474	.58 526	.01 419	.59 945	26
35	9.40 103	9.98 578	9.41 526	0.58 474	0.01 422	0.59 897	**25**
36	.40 152	.98 574	.41 578	.58 422	.01 426	.59 848	24
37	.40 200	.98 571	.41 629	.58 371	.01 429	.59 800	23
38	.40 249	.98 568	.41 681	.58 319	.01 432	.59 751	22
39	.40 297	.98 565	.41 733	.58 267	.01 435	.59 703	21
40	9.40 346	9.98 561	9.41 784	0.58 216	0.01 439	0.59 654	**20**
41	.40 394	.98 558	.41 836	.58 164	.01 442	.59 606	19
42	.40 442	.98 555	.41 887	.58 113	.01 445	.59 558	18
43	.40 490	.98 551	.41 939	.58 061	.01 449	.59 510	17
44	.40 538	.98 548	.41 990	.58 010	.01 452	.59 462	16
45	9.40 586	9.98 545	9.42 041	0.57 959	0.01 455	0.59 414	**15**
46	.40 634	.98 541	.42 093	.57 907	.01 459	.59 366	14
47	.40 682	.98 538	.42 144	.57 856	.01 462	.59 318	13
48	.40 730	.98 535	.42 195	.57 805	.01 465	.59 270	12
49	.40 778	.98 531	.42 246	.57 754	.01 469	.59 222	11
50	9.40 825	9.98 528	9.42 297	0.57 703	0.01 472	0.59 175	**10**
51	.40 873	.98 525	.42 348	.57 652	.01 475	.59 127	9
52	.40 921	.98 521	.42 399	.57 601	.01 479	.59 079	8
53	.40 968	.98 518	.42 450	.57 550	.01 482	.59 032	7
54	.41 016	.98 515	.42 501	.57 499	.01 485	.58 984	6
55	9.41 063	9.98 511	9.42 552	0.57 448	0.01 489	0.58 937	**5**
56	.41 111	.98 508	.42 603	.57 397	.01 492	.58 889	4
57	.41 158	.98 505	.42 653	.57 347	.01 495	.58 842	3
58	.41 205	.98 501	.42 704	.57 296	.01 499	.58 795	2
59	.41 252	.98 498	.42 755	.57 245	.01 502	.58 748	1
60	9.41 300	9.98 494	9.42 805	0.57 195	0.01 506	0.58 700	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

104° (284°) (255°) **75°**

15° (195°) (344°) **164°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.41 300	9.98 494	9.42 805	0.57 195	0.01 506	0.58 700	**60**
1	.41 347	.98 491	.42 856	.57 144	.01 509	.58 653	59
2	.41 394	.98 488	.42 906	.57 094	.01 512	.58 606	58
3	.41 441	.98 484	.42 957	.57 043	.01 516	.58 559	57
4	.41 488	.98 481	.43 007	.56 993	.01 519	.58 512	56
5	9.41 535	9.98 477	9.43 057	0.56 943	0.01 523	0.58 465	**55**
6	.41 582	.98 474	.43 108	.56 892	.01 526	.58 418	54
7	.41 628	.98 471	.43 158	.56 842	.01 529	.58 372	53
8	.41 675	.98 467	.43 208	.56 792	.01 533	.58 325	52
9	.41 722	.98 464	.43 258	.56 742	.01 536	.58 278	51
10	9.41 768	9.98 460	9.43 308	0.56 692	0.01 540	0.58 232	**50**
11	.41 815	.98 457	.43 358	.56 642	.01 543	.58 185	49
12	.41 861	.98 453	.43 408	.56 592	.01 547	.58 139	48
13	.41 908	.98 450	.43 458	.56 542	.01 550	.58 092	47
14	.41 954	.98 447	.43 508	.56 492	.01 553	.58 046	46
15	9.42 001	9.98 443	9.43 558	0.56 442	0.01 557	0.57 999	**45**
16	.42 047	.98 440	.43 607	.56 393	.01 560	.57 953	44
17	.42 093	.98 436	.43 657	.56 343	.01 564	.57 907	43
18	.42 140	.98 433	.43 707	.56 293	.01 567	.57 860	42
19	.42 186	.98 429	.43 756	.56 244	.01 571	.57 814	41
20	9.42 232	9.98 426	9.43 806	0.56 194	0.01 574	0.57 768	**40**
21	.42 278	.98 422	.43 855	.56 145	.01 578	.57 722	39
22	.42 324	.98 419	.43 905	.56 095	.01 581	.57 676	38
23	.42 370	.98 415	.43 954	.56 046	.01 585	.57 630	37
24	.42 416	.98 412	.44 004	.55 996	.01 588	.57 584	36
25	9.42 461	9.98 409	9.44 053	0.55 947	0.01 591	0.57 539	**35**
26	.42 507	.98 405	.44 102	.55 898	.01 595	.57 493	34
27	.42 553	.98 402	.44 151	.55 849	.01 598	.57 447	33
28	.42 599	.98 398	.44 201	.55 799	.01 602	.57 401	32
29	.42 644	.98 395	.44 250	.55 750	.01 605	.57 356	31
30	9.42 690	9.98 391	9.44 299	0.55 701	0.01 609	0.57 310	**30**
31	.42 735	.98 388	.44 348	.55 652	.01 612	.57 265	29
32	.42 781	.98 384	.44 397	.55 603	.01 616	.57 219	28
33	.42 826	.98 381	.44 446	.55 554	.01 619	.57 174	27
34	.42 872	.98 377	.44 495	.55 505	.01 623	.57 128	26
35	9.42 917	9.98 373	9.44 544	0.55 456	0.01 627	0.57 083	**25**
36	.42 962	.98 370	.44 592	.55 408	.01 630	.57 038	24
37	.43 008	.98 366	.44 641	.55 359	.01 634	.56 992	23
38	.43 053	.98 363	.44 690	.55 310	.01 637	.56 947	22
39	.43 098	.98 359	.44 738	.55 262	.01 641	.56 902	21
40	9.43 143	9.98 356	9.44 787	0.55 213	0.01 644	0.56 857	**20**
41	.43 188	.98 352	.44 836	.55 164	.01 648	.56 812	19
42	.43 233	.98 349	.44 884	.55 116	.01 651	.56 767	18
43	.43 278	.98 345	.44 933	.55 067	.01 655	.56 722	17
44	.43 323	.98 342	.44 981	.55 019	.01 658	.56 677	16
45	9.43 367	9.98 338	9.45 029	0.54 971	0.01 662	0.56 633	**15**
46	.43 412	.98 334	.45 078	.54 922	.01 666	.56 588	14
47	.43 457	.98 331	.45 126	.54 874	.01 669	.56 543	13
48	.43 502	.98 327	.45 174	.54 826	.01 673	.56 498	12
49	.43 546	.98 324	.45 222	.54 778	.01 676	.56 454	11
50	9.43 591	9.98 320	9.45 271	0.54 729	0.01 680	0.56 409	**10**
51	.43 635	.98 317	.45 319	.54 681	.01 683	.56 365	9
52	.43 680	.98 313	.45 367	.54 633	.01 687	.56 320	8
53	.43 724	.98 309	.45 415	.54 585	.01 691	.56 276	7
54	.43 769	.98 306	.45 463	.54 537	.01 694	.56 231	6
55	9.43 813	9.98 302	9.45 511	0.54 489	0.01 698	0.56 187	**5**
56	.43 857	.98 299	.45 559	.54 441	.01 701	.56 143	4
57	.43 901	.98 295	.45 606	.54 394	.01 705	.56 099	3
58	.43 946	.98 291	.45 654	.54 346	.01 709	.56 054	2
59	.43 990	.98 288	.45 702	.54 298	.01 712	.56 010	1
60	9.44 034	9.98 284	9.45 750	0.54 250	0.01 716	0.55 966	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

105° (285°) (254°) **74°**

16° (196°) (343°) **163°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.44 034	9.98 284	9.45 750	0.54 250	0.01 716	0.55 966	**60**
1	.44 078	.98 281	.45 797	.54 203	.01 719	.55 922	59
2	.44 122	.98 277	.45 845	.54 155	.01 723	.55 878	58
3	.44 166	.98 273	.45 892	.54 108	.01 727	.55 834	57
4	.44 210	.98 270	.45 940	.54 060	.01 730	.55 790	56
5	9.44 253	9.98 266	9.45 987	0.54 013	0.01 734	0.55 747	**55**
6	.44 297	.98 262	.46 035	.53 965	.01 738	.55 703	54
7	.44 341	.98 259	.46 082	.53 918	.01 741	.55 659	53
8	.44 385	.98 255	.46 130	.53 870	.01 745	.55 615	52
9	.44 428	.98 251	.46 177	.53 823	.01 749	.55 572	51
10	9.44 472	9.98 248	9.46 224	0.53 776	0.01 752	0.55 528	**50**
11	.44 516	.98 244	.46 271	.53 729	.01 756	.55 484	49
12	.44 559	.98 240	.46 319	.53 681	.01 760	.55 441	48
13	.44 602	.98 237	.46 366	.53 634	.01 763	.55 398	47
14	.44 646	.98 233	.46 413	.53 587	.01 767	.55 354	46
15	9.44 689	9.98 229	9.46 460	0.53 540	0.01 771	0.55 311	**45**
16	.44 733	.98 226	.46 507	.53 493	.01 774	.55 267	44
17	.44 776	.98 222	.46 554	.53 446	.01 778	.55 224	43
18	.44 819	.98 218	.46 601	.53 399	.01 782	.55 181	42
19	.44 862	.98 215	.46 648	.53 352	.01 785	.55 138	41
20	9.44 905	9.98 211	9.46 694	0.53 306	0.01 789	0.55 095	**40**
21	.44 948	.98 207	.46 741	.53 259	.01 793	.55 052	39
22	.44 992	.98 204	.46 788	.53 212	.01 796	.55 008	38
23	.45 035	.98 200	.46 835	.53 165	.01 800	.54 965	37
24	.45 077	.98 196	.46 881	.53 119	.01 804	.54 923	36
25	9.45 120	9.98 192	9.46 928	0.53 072	0.01 808	0.54 880	**35**
26	.45 163	.98 189	.46 975	.53 025	.01 811	.54 837	34
27	.45 206	.98 185	.47 021	.52 979	.01 815	.54 794	33
28	.45 249	.98 181	.47 068	.52 932	.01 819	.54 751	32
29	.45 292	.98 177	.47 114	.52 886	.01 823	.54 708	31
30	9.45 334	9.98 174	9.47 160	0.52 840	0.01 826	0.54 666	**30**
31	.45 377	.98 170	.47 207	.52 793	.01 830	.54 623	29
32	.45 419	.98 166	.47 253	.52 747	.01 834	.54 581	28
33	.45 462	.98 162	.47 299	.52 701	.01 838	.54 538	27
34	.45 504	.98 159	.47 346	.52 654	.01 841	.54 496	26
35	9.45 547	9.98 155	9.47 392	0.52 608	0.01 845	0.54 453	**25**
36	.45 589	.98 151	.47 438	.52 562	.01 849	.54 411	24
37	.45 632	.98 147	.47 484	.52 516	.01 853	.54 368	23
38	.45 674	.98 144	.47 530	.52 470	.01 856	.54 326	22
39	.45 716	.98 140	.47 576	.52 424	.01 860	.54 284	21
40	9.45 758	9.98 136	9.47 622	0.52 378	0.01 864	0.54 242	**20**
41	.45 801	.98 132	.47 668	.52 332	.01 868	.54 199	19
42	.45 843	.98 129	.47 714	.52 286	.01 871	.54 157	18
43	.45 885	.98 125	.47 760	.52 240	.01 875	.54 115	17
44	.45 927	.98 121	.47 806	.52 194	.01 879	.54 073	16
45	9.45 969	9.98 117	9.47 852	0.52 148	0.01 883	0.54 031	**15**
46	.46 011	.98 113	.47 897	.52 103	.01 887	.53 989	14
47	.46 053	.98 110	.47 943	.52 057	.01 890	.53 947	13
48	.46 095	.98 106	.47 989	.52 011	.01 894	.53 905	12
49	.46 136	.98 102	.48 035	.51 965	.01 898	.53 864	11
50	9.46 178	9.98 098	9.48 080	0.51 920	0.01 902	0.53 822	**10**
51	.46 220	.98 094	.48 126	.51 874	.01 906	.53 780	9
52	.46 262	.98 090	.48 171	.51 829	.01 910	.53 738	8
53	.46 303	.98 087	.48 217	.51 783	.01 913	.53 697	7
54	.46 345	.98 083	.48 262	.51 738	.01 917	.53 655	6
55	9.46 386	9.98 079	9.48 307	0.51 693	0.01 921	0.53 614	**5**
56	.46 428	.98 075	.48 353	.51 647	.01 925	.53 572	4
57	.46 469	.98 071	.48 398	.51 602	.01 929	.53 531	3
58	.46 511	.98 067	.48 443	.51 557	.01 933	.53 489	2
59	.46 552	.98 063	.48 489	.51 511	.01 937	.53 448	1
60	9.46 594	9.98 060	9.48 534	0.51 466	0.01 940	0.53 406	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

106° (286°) (253°) **73°**

17° (197°) (342°) 162°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.46 594	9.98 060	9.48 534	0.51 466	0.01 940	0.53 406	**60**
1	.46 635	.98 056	.48 579	.51 421	.01 944	.53 365	59
2	.46 676	.98 052	.48 624	.51 376	.01 948	.53 324	58
3	.46 717	.98 048	.48 669	.51 331	.01 952	.53 283	57
4	.46 758	.98 044	.48 714	.51 286	.01 956	.53 242	56
5	9.46 800	9.98 040	9.48 759	0.51 241	0.01 960	0.53 200	**55**
6	.46 841	.98 036	.48 804	.51 196	.01 964	.53 159	54
7	.46 882	.98 032	.48 849	.51 151	.01 968	.53 118	53
8	.46 923	.98 029	.48 894	.51 106	.01 971	.53 077	52
9	.46 964	.98 025	.48 939	.51 061	.01 975	.53 036	51
10	9.47 005	9.98 021	9.48 984	0.51 016	0.01 979	0.52 995	**50**
11	.47 045	.98 017	.49 029	.50 971	.01 983	.52 955	49
12	.47 086	.98 013	.49 073	.50 927	.01 987	.52 914	48
13	.47 127	.98 009	.49 118	.50 882	.01 991	.52 873	47
14	.47 168	.98 005	.49 163	.50 837	.01 995	.52 832	46
15	9.47 209	9.98 001	9.49 207	0.50 793	0.01 999	0.52 791	**45**
16	.47 249	.97 997	.49 252	.50 748	.02 003	.52 751	44
17	.47 290	.97 993	.49 296	.50 704	.02 007	.52 710	43
18	.47 330	.97 989	.49 341	.50 659	.02 011	.52 670	42
19	.47 371	.97 986	.49 385	.50 615	.02 014	.52 629	41
20	9.47 411	9.97 982	9.49 430	0.50 570	0.02 018	0.52 589	**40**
21	.47 452	.97 978	.49 474	.50 526	.02 022	.52 548	39
22	.47 492	.97 974	.49 519	.50 481	.02 026	.52 508	38
23	.47 533	.97 970	.49 563	.50 437	.02 030	.52 467	37
24	.47 573	.97 966	.49 607	.50 393	.02 034	.52 427	36
25	9.47 613	9.97 962	9.49 652	0.50 348	0.02 038	0.52 387	**35**
26	.47 654	.97 958	.49 696	.50 304	.02 042	.52 346	34
27	.47 694	.97 954	.49 740	.50 260	.02 046	.52 306	33
28	.47 734	.97 950	.49 784	.50 216	.02 050	.52 266	32
29	.47 774	.97 946	.49 828	.50 172	.02 054	.52 226	31
30	9.47 814	9.97 942	9.49 872	0.50 128	0.02 058	0.52 186	**30**
31	.47 854	.97 938	.49 916	.50 084	.02 062	.52 146	29
32	.47 894	.97 934	.49 960	.50 040	.02 066	.52 106	28
33	.47 934	.97 930	.50 004	.49 996	.02 070	.52 066	27
34	.47 974	.97 926	.50 048	.49 952	.02 074	.52 026	26
35	9.48 014	9.97 922	9.50 092	0.49 908	0.02 078	0.51 986	**25**
36	.48 054	.97 918	.50 136	.49 864	.02 082	.51 946	24
37	.48 094	.97 914	.50 180	.49 820	.02 086	.51 906	23
38	.48 133	.97 910	.50 223	.49 777	.02 090	.51 867	22
39	.48 173	.97 906	.50 267	.49 733	.02 094	.51 827	21
40	9.48 213	9.97 902	9.50 311	0.49 689	0.02 098	0.51 787	**20**
41	.48 252	.97 898	.50 355	.49 645	.02 102	.51 748	19
42	.48 292	.97 894	.50 398	.49 602	.02 106	.51 708	18
43	.48 332	.97 890	.50 442	.49 558	.02 110	.51 668	17
44	.48 371	.97 886	.50 485	.49 515	.02 114	.51 629	16
45	9.48 411	9.97 882	9.50 529	0.49 471	0.02 118	0.51 589	**15**
46	.48 450	.97 878	.50 572	.49 428	.02 122	.51 550	14
47	.48 490	.97 874	.50 616	.49 384	.02 126	.51 510	13
48	.48 529	.97 870	.50 659	.49 341	.02 130	.51 471	12
49	.48 568	.97 866	.50 703	.49 297	.02 134	.51 432	11
50	9.48 607	9.97 861	9.50 746	0.49 254	0.02 139	0.51 393	**10**
51	.48 647	.97 857	.50 789	.49 211	.02 143	.51 353	9
52	.48 686	.97 853	.50 833	.49 167	.02 147	.51 314	8
53	.48 725	.97 849	.50 876	.49 124	.02 151	.51 275	7
54	.48 764	.97 845	.50 919	.49 081	.02 155	.51 236	6
55	9.48 803	9.97 841	9.50 962	0.49 038	0.02 159	0.51 197	**5**
56	.48 842	.97 837	.51 005	.48 995	.02 163	.51 158	4
57	.48 881	.97 833	.51 048	.48 952	.02 167	.51 119	3
58	.48 920	.97 829	.51 092	.48 908	.02 171	.51 080	2
59	.48 959	.97 825	.51 135	.48 865	.02 175	.51 041	1
60	9.48 998	9.97 821	9.51 178	0.48 822	0.02 179	0.51 002	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

107° (287°) (252°) 72°

18° (198°) (341°) 161°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.48 998	9.97 821	9.51 178	0.48 822	0.02 179	0.51 002	**60**
1	.49 037	.97 817	.51 221	.48 779	.02 183	.50 963	59
2	.49 076	.97 812	.51 264	.48 736	.02 188	.50 924	58
3	.49 115	.97 808	.51 306	.48 694	.02 192	.50 885	57
4	.49 153	.97 804	.51 349	.48 651	.02 196	.50 847	56
5	9.49 192	9.97 800	9.51 392	0.48 608	0.02 200	0.50 808	**55**
6	.49 231	.97 796	.51 435	.48 565	.02 204	.50 769	54
7	.49 269	.97 792	.51 478	.48 522	.02 208	.50 731	53
8	.49 308	.97 788	.51 520	.48 480	.02 212	.50 692	52
9	.49 347	.97 784	.51 563	.48 437	.02 216	.50 653	51
10	9.49 385	9.97 779	9.51 606	0.48 394	0.02 221	0.50 615	**50**
11	.49 424	.97 775	.51 648	.48 352	.02 225	.50 576	49
12	.49 462	.97 771	.51 691	.48 309	.02 229	.50 538	48
13	.49 500	.97 767	.51 734	.48 266	.02 233	.50 500	47
14	.49 539	.97 763	.51 776	.48 224	.02 237	.50 461	46
15	9.49 577	9.97 759	9.51 819	0.48 181	0.02 241	0.50 423	**45**
16	.49 615	.97 754	.51 861	.48 139	.02 246	.50 385	44
17	.49 654	.97 750	.51 903	.48 097	.02 250	.50 346	43
18	.49 692	.97 746	.51 946	.48 054	.02 254	.50 308	42
19	.49 730	.97 742	.51 988	.48 012	.02 258	.50 270	41
20	9.49 768	9.97 738	9.52 031	0.47 969	0.02 262	0.50 232	**40**
21	.49 806	.97 734	.52 073	.47 927	.02 266	.50 194	39
22	.49 844	.97 729	.52 115	.47 885	.02 271	.50 156	38
23	.49 882	.97 725	.52 157	.47 843	.02 275	.50 118	37
24	.49 920	.97 721	.52 200	.47 800	.02 279	.50 080	36
25	9.49 958	9.97 717	9.52 242	0.47 758	0.02 283	0.50 042	**35**
26	.49 996	.97 713	.52 284	.47 716	.02 287	.50 004	34
27	.50 034	.97 708	.52 326	.47 674	.02 292	.49 966	33
28	.50 072	.97 704	.52 368	.47 632	.02 296	.49 928	32
29	.50 110	.97 700	.52 410	.47 590	.02 300	.49 890	31
30	9.50 148	9.97 696	9.52 452	0.47 548	0.02 304	0.49 852	**30**
31	.50 185	.97 691	.52 494	.47 506	.02 309	.49 815	29
32	.50 223	.97 687	.52 536	.47 464	.02 313	.49 777	28
33	.50 261	.97 683	.52 578	.47 422	.02 317	.49 739	27
34	.50 298	.97 679	.52 620	.47 380	.02 321	.49 702	26
35	9.50 336	9.97 674	9.52 661	0.47 339	0.02 326	0.49 664	**25**
36	.50 374	.97 670	.52 703	.47 297	.02 330	.49 626	24
37	.50 411	.97 666	.52 745	.47 255	.02 334	.49 589	23
38	.50 449	.97 662	.52 787	.47 213	.02 338	.49 551	22
39	.50 486	.97 657	.52 829	.47 171	.02 343	.49 514	21
40	9.50 523	9.97 653	9.52 870	0.47 130	0.02 347	0.49 477	**20**
41	.50 561	.97 649	.52 912	.47 088	.02 351	.49 439	19
42	.50 598	.97 645	.52 953	.47 047	.02 355	.49 402	18
43	.50 635	.97 640	.52 995	.47 005	.02 360	.49 365	17
44	.50 673	.97 636	.53 037	.46 963	.02 364	.49 327	16
45	9.50 710	9.97 632	9.53 078	0.46 922	0.02 368	0.49 290	**15**
46	.50 747	.97 628	.53 120	.46 880	.02 372	.49 253	14
47	.50 784	.97 623	.53 161	.46 839	.02 377	.49 216	13
48	.50 821	.97 619	.53 202	.46 798	.02 381	.49 179	12
49	.50 858	.97 615	.53 244	.46 756	.02 385	.49 142	11
50	9.50 896	9.97 610	9.53 285	0.46 715	0.02 390	0.49 104	**10**
51	.50 933	.97 606	.53 327	.46 673	.02 394	.49 067	9
52	.50 970	.97 602	.53 368	.46 632	.02 398	.49 030	8
53	.51 007	.97 597	.53 409	.46 591	.02 403	.48 993	7
54	.51 043	.97 593	.53 450	.46 550	.02 407	.48 957	6
55	9.51 080	9.97 589	9.53 492	0.46 508	0.02 411	0.48 920	**5**
56	.51 117	.97 584	.53 533	.46 467	.02 416	.48 883	4
57	.51 154	.97 580	.53 574	.46 426	.02 420	.48 846	3
58	.51 191	.97 576	.53 615	.46 385	.02 424	.48 809	2
59	.51 227	.97 571	.53 656	.46 344	.02 429	.48 773	1
60	9.51 264	9.97 567	9.53 697	0.46 303	0.02 433	0.48 736	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

108° (288°) (251°) 71°

19° (199°) (340°) 160°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.51 264	9.97 567	9.53 697	0.46 303	0.02 433	0.48 736	**60**
1	.51 301	.97 563	.53 738	.46 262	.02 437	.48 699	59
2	.51 338	.97 558	.53 779	.46 221	.02 442	.48 662	58
3	.51 374	.97 554	.53 820	.46 180	.02 446	.48 626	57
4	.51 411	.97 550	.53 861	.46 139	.02 450	.48 589	56
5	9.51 447	9.97 545	9.53 902	0.46 098	0.02 455	0.48 553	**55**
6	.51 484	.97 541	.53 943	.46 057	.02 459	.48 516	54
7	.51 520	.97 536	.53 984	.46 016	.02 464	.48 480	53
8	.51 557	.97 532	.54 025	.45 975	.02 468	.48 443	52
9	.51 593	.97 528	.54 065	.45 935	.02 472	.48 407	51
10	9.51 629	9.97 523	9.54 106	0.45 894	0.02 477	0.48 371	**50**
11	.51 666	.97 519	.54 147	.45 853	.02 481	.48 334	49
12	.51 702	.97 515	.54 187	.45 813	.02 485	.48 298	48
13	.51 738	.97 510	.54 228	.45 772	.02 490	.48 262	47
14	.51 774	.97 506	.54 269	.45 731	.02 494	.48 226	46
15	9.51 811	9.97 501	9.54 309	0.45 691	0.02 499	0.48 189	**45**
16	.51 847	.97 497	.54 350	.45 650	.02 503	.48 153	44
17	.51 883	.97 492	.54 390	.45 610	.02 508	.48 117	43
18	.51 919	.97 488	.54 431	.45 569	.02 512	.48 081	42
19	.51 955	.97 484	.54 471	.45 529	.02 516	.48 045	41
20	9.51 991	9.97 479	9.54 512	0.45 488	0.02 521	0.48 009	**40**
21	.52 027	.97 475	.54 552	.45 448	.02 525	.47 973	39
22	.52 063	.97 470	.54 593	.45 407	.02 530	.47 937	38
23	.52 099	.97 466	.54 633	.45 367	.02 534	.47 901	37
24	.52 135	.97 461	.54 673	.45 327	.02 539	.47 865	36
25	9.52 171	9.97 457	9.54 714	0.45 286	0.02 543	0.47 829	**35**
26	.52 207	.97 453	.54 754	.45 246	.02 547	.47 793	34
27	.52 242	.97 448	.54 794	.45 206	.02 552	.47 758	33
28	.52 278	.97 444	.54 835	.45 165	.02 556	.47 722	32
29	.52 314	.97 439	.54 875	.45 125	.02 561	.47 686	31
30	9.52 350	9.97 435	9.54 915	0.45 085	0.02 565	0.47 650	**30**
31	.52 385	.97 430	.54 955	.45 045	.02 570	.47 615	29
32	.52 421	.97 426	.54 995	.45 005	.02 574	.47 579	28
33	.52 456	.97 421	.55 035	.44 965	.02 579	.47 544	27
34	.52 492	.97 417	.55 075	.44 925	.02 583	.47 508	26
35	9.52 527	9.97 412	9.55 115	0.44 885	0.02 588	0.47 473	**25**
36	.52 563	.97 408	.55 155	.44 845	.02 592	.47 437	24
37	.52 598	.97 403	.55 195	.44 805	.02 597	.47 402	23
38	.52 634	.97 399	.55 235	.44 765	.02 601	.47 366	22
39	.52 669	.97 394	.55 275	.44 725	.02 606	.47 331	21
40	9.52 705	9.97 390	9.55 315	0.44 685	0.02 610	0.47 295	**20**
41	.52 740	.97 385	.55 355	.44 645	.02 615	.47 260	19
42	.52 775	.97 381	.55 395	.44 605	.02 619	.47 225	18
43	.52 811	.97 376	.55 434	.44 566	.02 624	.47 189	17
44	.52 846	.97 372	.55 474	.44 526	.02 628	.47 154	16
45	9.52 881	9.97 367	9.55 514	0.44 486	0.02 633	0.47 119	**15**
46	.52 916	.97 363	.55 554	.44 446	.02 637	.47 084	14
47	.52 951	.97 358	.55 593	.44 407	.02 642	.47 049	13
48	.52 986	.97 353	.55 633	.44 367	.02 647	.47 014	12
49	.53 021	.97 349	.55 673	.44 327	.02 651	.46 979	11
50	9.53 056	9.97 344	9.55 712	0.44 288	0.02 656	0.46 944	**10**
51	.53 092	.97 340	.55 752	.44 248	.02 660	.46 908	9
52	.53 126	.97 335	.55 791	.44 209	.02 665	.46 874	8
53	.53 161	.97 331	.55 831	.44 169	.02 669	.46 839	7
54	.53 196	.97 326	.55 870	.44 130	.02 674	.46 804	6
55	9.53 231	9.97 322	9.55 910	0.44 090	0.02 678	0.46 769	**5**
56	.53 266	.97 317	.55 949	.44 051	.02 683	.46 734	4
57	.53 301	.97 312	.55 989	.44 011	.02 688	.46 699	3
58	.53 336	.97 308	.56 028	.43 972	.02 692	.46 664	2
59	.53 370	.97 303	.56 067	.43 933	.02 697	.46 630	1
60	9.53 405	9.97 299	9.56 107	9.43 893	0.02 701	0.46 595	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

109° (289°) (250°) 70°

20° (200°) (339°) **159°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.53 405	9.97 299	9.56 107	0.43 893	0.02 701	0.46 595	**60**
1	.53 440	.97 294	.56 146	.43 854	.02 706	.46 560	59
2	.53 475	.97 289	.56 185	.43 815	.02 711	.46 525	58
3	.53 509	.97 285	.56 224	.43 776	.02 715	.46 491	57
4	.53 544	.97 280	.56 264	.43 736	.02 720	.46 456	56
5	9.53 578	9.97 276	9.56 303	0.43 697	0.02 724	0.46 422	**55**
6	.53 613	.97 271	.56 342	.43 658	.02 729	.46 387	54
7	.53 647	.97 266	.56 381	.43 619	.02 734	.46 353	53
8	.53 682	.97 262	.56 420	.43 580	.02 738	.46 318	52
9	.53 716	.97 257	.56 459	.43 541	.02 743	.46 284	51
10	9.53 751	9.97 252	9.56 498	0.43 502	0.02 748	0.46 249	**50**
11	.53 785	.97 248	.56 537	.43 463	.02 752	.46 215	49
12	.53 819	.97 243	.56 576	.43 424	.02 757	.46 181	48
13	.53 854	.97 238	.56 615	.43 385	.02 762	.46 146	47
14	.53 888	.97 234	.56 654	.43 346	.02 766	.46 112	46
15	9.53 922	9.97 229	9.56 693	0.43 307	0.02 771	0.46 078	**45**
16	.53 957	.97 224	.56 732	.43 268	.02 776	.46 043	44
17	.53 991	.97 220	.56 771	.43 229	.02 780	.46 009	43
18	.54 025	.97 215	.56 810	.43 190	.02 785	.45 975	42
19	.54 059	.97 210	.56 849	.43 151	.02 790	.45 941	41
20	9.54 093	9.97 206	9.56 887	0.43 113	0.02 794	0.45 907	**40**
21	.54 127	.97 201	.56 926	.43 074	.02 799	.45 873	39
22	.54 161	.97 196	.56 965	.43 035	.02 804	.45 839	38
23	.54 195	.97 192	.57 004	.42 996	.02 808	.45 805	37
24	.54 229	.97 187	.57 042	.42 958	.02 813	.45 771	36
25	9.54 263	9.97 182	9.57 081	0.42 919	0.02 818	0.45 737	**35**
26	.54 297	.97 178	.57 120	.42 880	.02 822	.45 703	34
27	.54 331	.97 173	.57 158	.42 842	.02 827	.45 669	33
28	.54 365	.97 168	.57 197	.42 803	.02 832	.45 635	32
29	.54 399	.97 163	.57 235	.42 765	.02 837	.45 601	31
30	9.54 433	9.97 159	9.57 274	0.42 726	0.02 841	0.45 567	**30**
31	.54 466	.97 154	.57 312	.42 688	.02 846	.45 534	29
32	.54 500	.97 149	.57 351	.42 649	.02 851	.45 500	28
33	.54 534	.97 145	.57 389	.42 611	.02 855	.45 466	27
34	.54 567	.97 140	.57 428	.42 572	.02 860	.45 433	26
35	9.54 601	9.97 135	9.57 466	0.42 534	0.02 865	0.45 399	**25**
36	.54 635	.97 130	.57 504	.42 496	.02 870	.45 365	24
37	.54 668	.97 126	.57 543	.42 457	.02 874	.45 332	23
38	.54 702	.97 121	.57 581	.42 419	.02 879	.45 298	22
39	.54 735	.97 116	.57 619	.42 381	.02 884	.45 265	21
40	9.54 769	9.97 111	9.57 658	0.42 342	0.02 889	0.45 231	**20**
41	.54 802	.97 107	.57 696	.42 304	.02 893	.45 198	19
42	.54 836	.97 102	.57 734	.42 266	.02 898	.45 164	18
43	.54 869	.97 097	.57 772	.42 228	.02 903	.45 131	17
44	.54 903	.97 092	.57 810	.42 190	.02 908	.45 097	16
45	9.54 936	9.97 087	9.57 849	0.42 151	0.02 913	0.45 064	**15**
46	.54 969	.97 083	.57 887	.42 113	.02 917	.45 031	14
47	.55 003	.97 078	.57 925	.42 075	.02 922	.44 997	13
48	.55 036	.97 073	.57 963	.42 037	.02 927	.44 964	12
49	.55 069	.97 068	.58 001	.41 999	.02 932	.44 931	11
50	9.55 102	9.97 063	9.58 039	0.41 961	0.02 937	0.44 898	**10**
51	.55 136	.97 059	.58 077	.41 923	.02 941	.44 864	9
52	.55 169	.97 054	.58 115	.41 885	.02 946	.44 831	8
53	.55 202	.97 049	.58 153	.41 847	.02 951	.44 798	7
54	.55 235	.97 044	.58 191	.41 809	.02 956	.44 765	6
55	9.55 268	9.97 039	9.58 229	0.41 771	0.02 961	0.44 732	**5**
56	.55 301	.97 035	.58 267	.41 733	.02 965	.44 699	4
57	.55 334	.97 030	.58 304	.41 696	.02 970	.44 666	3
58	.55 367	.97 025	.58 342	.41 658	.02 975	.44 633	2
59	.55 400	.97 020	.58 380	.41 620	.02 980	.44 600	1
60	9.55 433	9.97 015	9.58 418	0.41 582	0.02 985	0.44 567	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

110° (290°) (249°) **69°**

21° (201°) (338°) 158°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.55 433	9.97 015	9.58 418	0.41 582	0.02 985	0.44 567	**60**
1	.55 466	.97 010	.58 455	.41 545	.02 990	.44 534	59
2	.55 499	.97 005	.58 493	.41 507	.02 995	.44 501	58
3	.55 532	.97 001	.58 531	.41 469	.02 999	.44 468	57
4	.55 564	.96 996	.58 569	.41 431	.03 004	.44 436	56
5	9.55 597	9.96 991	9.58 606	0.41 394	0.03 009	0.44 403	**55**
6	.55 630	.96 986	.58 644	.41 356	.03 014	.44 370	54
7	.55 663	.96 981	.58 681	.41 319	.03 019	.44 337	53
8	.55 695	.96 976	.58 719	.41 281	.03 024	.44 305	52
9	.55 728	.96 971	.58 757	.41 243	.03 029	.44 272	51
10	9.55 761	9.96 966	9.58 794	0.41 206	0.03 034	0.44 239	**50**
11	.55 793	.96 962	.58 832	.41 168	.03 038	.44 207	49
12	.55 826	.96 957	.58 869	.41 131	.03 043	.44 174	48
13	.55 858	.96 952	.58 907	.41 093	.03 048	.44 142	47
14	.55 891	.96 947	.58 944	.41 056	.03 053	.44 109	46
15	9.55 923	9.96 942	9.58 981	0.41 019	0.03 058	0.44 077	**45**
16	.55 956	.96 937	.59 019	.40 981	.03 063	.44 044	44
17	.55 988	.96 932	.59 056	.40 944	.03 068	.44 012	43
18	.56 021	.96 927	.59 094	.40 906	.03 073	.43 979	42
19	.56 053	.96 922	.59 131	.40 869	.03 078	.43 947	41
20	9.56 085	9.96 917	9.59 168	0.40 832	0.03 083	0.43 915	**40**
21	.56 118	.96 912	.59 205	.40 795	.03 088	.43 882	39
22	.56 150	.96 907	.59 243	.40 757	.03 093	.43 850	38
23	.56 182	.96 903	.59 280	.40 720	.03 097	.43 818	37
24	.56 215	.96 898	.59 317	.40 683	.03 102	.43 785	36
25	9.56 247	9.96 893	9.59 354	0.40 646	0.03 107	0.43 753	**35**
26	.56 279	.96 888	.59 391	.40 609	.03 112	.43 721	34
27	.56 311	.96 883	.59 429	.40 571	.03 117	.43 689	33
28	.56 343	.96 878	.59 466	.40 534	.03 122	.43 657	32
29	.56 375	.96 873	.59 503	.40 497	.03 127	.43 625	31
30	9.56 408	9.96 868	9.59 540	0.40 460	0.03 132	0.43 592	**30**
31	.56 440	.96 863	.59 577	.40 423	.03 137	.43 560	29
32	.56 472	.96 858	.59 614	.40 386	.03 142	.43 528	28
33	.56 504	.96 853	.59 651	.40 349	.03 147	.43 496	27
34	.56 536	.96 848	.59 688	.40 312	.03 152	.43 464	26
35	9.56 568	9.96 843	9.59 725	0.40 275	0.03 157	0.43 432	**25**
36	.56 599	.96 838	.59 762	.40 238	.03 162	.43 401	24
37	.56 631	.96 833	.59 799	.40 201	.03 167	.43 369	23
38	.56 663	.96 828	.59 835	.40 165	.03 172	.43 337	22
39	.56 695	.96 823	.59 872	.40 128	.03 177	.43 305	21
40	9.56 727	9.96 818	9.59 909	0.40 091	0.03 182	0.43 273	**20**
41	.56 759	.96 813	.59 946	.40 054	.03 187	.43 241	19
42	.56 790	.96 808	.59 983	.40 017	.03 192	.43 210	18
43	.56 822	.96 803	.60 019	.39 981	.03 197	.43 178	17
44	.56 854	.96 798	.60 056	.39 944	.03 202	.43 146	16
45	9.56 886	9.96 793	9.60 093	0.39 907	0.03 207	0.43 114	**15**
46	.56 917	.96 788	.60 130	.39 870	.03 212	.43 083	14
47	.56 949	.96 783	.60 166	.39 834	.03 217	.43 051	13
48	.56 980	.96 778	.60 203	.39 797	.03 222	.43 020	12
49	.57 012	.96 772	.60 240	.39 760	.03 228	.42 988	11
50	9.57 044	9.96 767	9.60 276	0.39 724	0.03 233	0.42 956	**10**
51	.57 075	.96 762	.60 313	.39 687	.03 238	.42 925	9
52	.57 107	.96 757	.60 349	.39 651	.03 243	.42 893	8
53	.57 138	.96 752	.60 386	.39 614	.03 248	.42 862	7
54	.57 169	.96 747	.60 422	.39 578	.03 253	.42 831	6
55	9.57 201	9.96 742	9.60 459	0.39 541	0.03 258	0.42 799	**5**
56	.57 232	.96 737	.60 495	.39 505	.03 263	.42 768	4
57	.57 264	.96 732	.60 532	.39 468	.03 268	.42 736	3
58	.57 295	.96 727	.60 568	.39 432	.03 273	.42 705	2
59	.57 326	.96 722	.60 605	.39 395	.03 278	.42 674	1
60	9.57 358	9.96 717	9.60 641	0.39 359	0.03 283	0.42 642	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

111° (291°) (248°) 68°

22° (202°) (337°) **157°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.57 358	9.96 717	9.60 641	0.39 359	0.03 283	0.42 642	**60**
1	.57 389	.96 711	.60 677	.39 323	.03 289	.42 611	59
2	.57 420	.96 706	.60 714	.39 286	.03 294	.42 580	58
3	.57 451	.96 701	.60 750	.39 250	.03 299	.42 549	57
4	.57 482	.96 696	.60 786	.39 214	.03 304	.42 518	56
5	9.57 514	9.96 691	9.60 823	0.39 177	0.03 309	0.42 486	**55**
6	.57 545	.96 686	.60 859	.39 141	.03 314	.42 455	54
7	.57 576	.96 681	.60 895	.39 105	.03 319	.42 424	53
8	.57 607	.96 676	.60 931	.39 069	.03 324	.42 393	52
9	.57 638	.96 670	.60 967	.39 033	.03 330	.42 362	51
10	9.57 669	9.96 665	9.61 004	9.38 996	0.03 335	0.42 331	**50**
11	.57 700	.96 660	.61 040	.38 960	.03 340	.42 300	49
12	.57 731	.96 655	.61 076	.38 924	.03 345	.42 269	48
13	.57 762	.96 650	.61 112	.38 888	.03 350	.42 238	47
14	.57 793	.96 645	.61 148	.38 852	.03 355	.42 207	46
15	9.57 824	9.96 640	9.61 184	0.38 816	0.03 360	0.42 176	**45**
16	.57 855	.96 634	.61 220	.38 780	.03 366	.42 145	44
17	.57 885	.96 629	.61 256	.38 744	.03 371	.42 115	43
18	.57 916	.96 624	.61 292	.38 708	.03 376	.42 084	42
19	.57 947	.96 619	.61 328	.38 672	.03 381	.42 053	41
20	9.57 978	9.96 614	9.61 364	0.38 636	0.03 386	0.42 022	**40**
21	.58 008	.96 608	.61 400	.38 600	.03 392	.41 992	39
22	.58 039	.96 603	.61 436	.38 564	.03 397	.41 961	38
23	.58 070	.96 598	.61 472	.38 528	.03 402	.41 930	37
24	.58 101	.96 593	.61 508	.38 492	.03 407	.41 899	36
25	9.58 131	9.96 588	9.61 544	0.38 456	0.03 412	0.41 869	**35**
26	.58 162	.96 582	.61 579	.38 421	.03 418	.41 838	34
27	.58 192	.96 577	.61 615	.38 385	.03 423	.41 808	33
28	.58 223	.96 572	.61 651	.38 349	.03 428	.41 777	32
29	.58 253	.96 567	.61 687	.38 313	.03 433	.41 747	31
30	9.58 284	9.96 562	9.61 722	0.38 278	0.03 438	0.41 716	**30**
31	.58 314	.96 556	.61 758	.38 242	.03 444	.41 686	29
32	.58 345	.96 551	.61 794	.38 206	.03 449	.41 655	28
33	.58 375	.96 546	.61 830	.38 170	.03 454	.41 625	27
34	.58 406	.96 541	.61 865	.38 135	.03 459	.41 594	26
35	9.58 436	9.96 535	9.61 901	0.38 099	0.03 465	0.41 564	**25**
36	.58 467	.96 530	.61 936	.38 064	.03 470	.41 533	24
37	.58 497	.96 525	.61 972	.38 028	.03 475	.41 503	23
38	.58 527	.96 520	.62 008	.37 992	.03 480	.41 473	22
39	.58 557	.96 514	.62 043	.37 957	.03 486	.41 443	21
40	9.58 588	9.96 509	9.62 079	0.37 921	0.03 491	0.41 412	**20**
41	.58 618	.96 504	.62 114	.37 886	.03 496	.41 382	19
42	.58 648	.96 498	.62 150	.37 850	.03 502	.41 352	18
43	.58 678	.96 493	.62 185	.37 815	.03 507	.41 322	17
44	.58 709	.96 488	.62 221	.37 779	.03 512	.41 291	16
45	9.58 739	9.96 483	9.62 256	0.37 744	0.03 517	0.41 261	**15**
46	.58 769	.96 477	.62 292	.37 708	.03 523	.41 231	14
47	.58 799	.96 472	.62 327	.37 673	.03 528	.41 201	13
48	.58 829	.96 467	.62 362	.37 638	.03 533	.41 171	12
49	.58 859	.96 461	.62 398	.37 602	.03 539	.41 141	11
50	9.58 889	9.96 456	9.62 433	0.37 567	0.03 544	0.41 111	**10**
51	.58 919	.96 451	.62 468	.37 532	.03 549	.41 081	9
52	.58 949	.96 445	.62 504	.37 496	.03 555	.41 051	8
53	.58 979	.96 440	.62 539	.37 461	.03 560	.41 021	7
54	.59 009	.96 435	.62 574	.37 426	.03 565	.40 991	6
55	9.59 039	9.96 429	9.62 609	0.37 391	0.03 571	0.40 961	**5**
56	.59 069	.96 424	.62 645	.37 355	.03 576	.40 931	4
57	.59 098	.96 419	.62 680	.37 320	.03 581	.40 902	3
58	.59 128	.96 413	.62 715	.37 285	.03 587	.40 872	2
59	.59 158	.96 408	.62 750	.37 250	.03 592	.40 842	1
60	9.59 188	9.96 403	9.62 785	0.37 215	0.03 597	0.40 812	**0**
	Cos	**Sin**	**Cot**	**Tan**	**Csc**	**Sec**	′

112° (292°) (247°) **67°**

23° (203°) (336°) **156°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.59 188	9.96 403	9.62 785	0.37 215	0.03 597	0.40 812	**60**
1	.59 218	.96 397	.62 820	.37 180	.03 603	.40 782	59
2	.59 247	.96 392	.62 855	.37 145	.03 608	.40 753	58
3	.59 277	.96 387	.62 890	.37 110	.03 613	.40 723	57
4	.59 307	.96 381	.62 926	.37 074	.03 619	.40 693	56
5	9.59 336	9.96 376	9.62 961	0.37 039	0.03 624	0.40 664	**55**
6	.59 366	.96 370	.62 996	.37 004	.03 630	.40 634	54
7	.59 396	.96 365	.63 031	.36 969	.03 635	.40 604	53
8	.59 425	.96 360	.63 066	.36 934	.03 640	.40 575	52
9	.59 455	.96 354	.63 101	.36 899	.03 646	.40 545	51
10	9.59 484	9.96 349	9.63 135	0.36 865	0.03 651	0.40 516	**50**
11	.59 514	.96 343	.63 170	.36 830	.03 657	.40 486	49
12	.59 543	.96 338	.63 205	.36 795	.03 662	.40 457	48
13	.59 573	.96 333	.63 240	.36 760	.03 667	.40 427	47
14	.59 602	.96 327	.63 275	.36 725	.03 673	.40 398	46
15	9.59 632	9.96 322	9.63 310	0.36 690	0.03 678	0.40 368	**45**
16	.59 661	.96 316	.63 345	.36 655	.03 684	.40 339	44
17	.59 690	.96 311	.63 379	.36 621	.03 689	.40 310	43
18	.59 720	.96 305	.63 414	.36 586	.03 695	.40 280	42
19	.59 749	.96 300	.63 449	.36 551	.03 700	.40 251	41
20	9.59 778	9.96 294	9.63 484	0.36 516	0.03 706	0.40 222	**40**
21	.59 808	.96 289	.63 519	.36 481	.03 711	.40 192	39
22	.59 837	.96 284	.63 553	.36 447	.03 716	.40 163	38
23	.59 866	.96 278	.63 588	.36 412	.03 722	.40 134	37
24	.59 895	.96 273	.63 623	.36 377	.03 727	.40 105	36
25	9.59 924	9.96 267	9.63 657	0.36 343	0.03 733	0.40 076	**35**
26	.59 954	.96 262	.63 692	.36 308	.03 738	.40 046	34
27	.59 983	.96 256	.63 726	.36 274	.03 744	.40 017	33
28	.60 012	.96 251	.63 761	.36 239	.03 749	.39 988	32
29	.60 041	.96 245	.63 796	.36 204	.03 755	.39 959	31
30	9.60 070	9.96 240	9.63 830	0.36 170	0.03 760	.39 930	**30**
31	.60 099	.96 234	.63 865	.36 135	.03 766	.39 901	29
32	.60 128	.96 229	.63 899	.36 101	.03 771	.39 872	28
33	.60 157	.96 223	.63 934	.36 066	.03 777	.39 843	27
34	.60 186	.96 218	.63 968	.36 032	.03 782	.39 814	26
35	9.60 215	9.96 212	9.64 003	0.35 997	0.03 788	0.39 785	**25**
36	.60 244	.96 207	.64 037	.35 963	.03 793	.39 756	24
37	.60 273	.96 201	.64 072	.35 928	.03 799	.39 727	23
38	.60 302	.96 196	.64 106	.35 894	.03 804	.39 698	22
39	.60 331	.96 190	.64 140	.35 860	.03 810	.39 669	21
40	9.60 359	9.96 185	9.64 175	0.35 825	0.03 815	0.39 641	**20**
41	.60 388	.96 179	.64 209	.35 791	.03 821	.39 612	19
42	.60 417	.96 174	.64 243	.35 757	.03 826	.39 583	18
43	.60 446	.96 168	.64 278	.35 722	.03 832	.39 554	17
44	.60 474	.96 162	.64 312	.35 688	.03 838	.39 526	16
45	9.60 503	9.96 157	9.64 346	0.35 654	0.03 843	0.39 497	**15**
46	.60 532	.96 151	.64 381	.35 619	.03 849	.39 468	14
47	.60 561	.96 146	.64 415	.35 585	.03 854	.39 439	13
48	.60 589	.96 140	.64 449	.35 551	.03 860	.39 411	12
49	.60 618	.96 135	.64 483	.35 517	.03 865	.39 382	11
50	9.60 646	9.96 129	9.64 517	0.35 483	0.03 871	0.39 354	**10**
51	.60 675	.96 123	.64 552	.35 448	.03 877	.39 325	9
52	.60 704	.96 118	.64 586	.35 414	.03 882	.39 296	8
53	.60 732	.96 112	.64 620	.35 380	.03 888	.39 268	7
54	.60 761	.96 107	.64 654	.35 346	.03 893	.39 239	6
55	9.60 789	9.96 101	9.64 688	0.35 312	0.03 899	0.39 211	**5**
56	.60 818	.96 095	.64 722	.35 278	.03 905	.39 182	4
57	.60 846	.96 090	.64 756	.35 244	.03 910	.39 154	3
58	.60 875	.96 084	.64 790	.35 210	.03 916	.39 125	2
59	.60 903	.96 079	.64 824	.35 176	.03 921	.39 097	1
60	9.60 931	9.96 073	9.64 858	0.35 142	0.03 927	0.39 069	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

113° (293°) (246°) **66°**

24° (204°) (335°) **155°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.60 931	9.96 073	9.64 858	0.35 142	0.03 927	0.39 069	**60**
1	.60 960	.96 067	.64 892	.35 108	.03 933	.39 040	59
2	.60 988	.96 062	.64 926	.35 074	.03 938	.39 012	58
3	.61 016	.96 056	.64 960	.35 040	.03 944	.38 984	57
4	.61 045	.96 050	.64 994	.35 006	.03 950	.38 955	56
5	9.61 073	9.96 045	9.65 028	0.34 972	0.03 955	0.38 927	**55**
6	.61 101	.96 039	.65 062	.34 938	.03 961	.38 899	54
7	.61 129	.96 034	.65 096	.34 904	.03 966	.38 871	53
8	.61 158	.96 028	.65 130	.34 870	.03 972	.38 842	52
9	.61 186	.96 022	.65 164	.34 836	.03 978	.38 814	51
10	9.61 214	9.96 017	9.65 197	0.34 803	0.03 983	0.38 786	**50**
11	.61 242	.96 011	.65 231	.34 769	.03 989	.38 758	49
12	.61 270	.96 005	.65 265	.34 735	.03 995	.38 730	48
13	.61 298	.96 000	.65 299	.34 701	.04 000	.38 702	47
14	.61 326	.95 994	.65 333	.34 667	.04 006	.38 674	46
15	9.61 354	9.95 988	9.65 366	0.34 634	0.04 012	0.38 646	**45**
16	.61 382	.95 982	.65 400	.34 600	.04 018	.38 618	44
17	.61 411	.95 977	.65 434	.34 566	.04 023	.38 589	43
18	.61 438	.95 971	.65 467	.34 533	.04 029	.38 562	42
19	.61 466	.95 965	.65 501	.34 499	.04 035	.38 534	41
20	9.61 494	9.95 960	9.65 535	0.34 465	0.04 040	0.38 506	**40**
21	.61 522	.95 954	.65 568	.34 432	.04 046	.38 478	39
22	.61 550	.95 948	.65 602	.34 398	.04 052	.38 450	38
23	.61 578	.95 942	.65 636	.34 364	.04 058	.38 422	37
24	.61 606	.95 937	.65 669	.34 331	.04 063	.38 394	36
25	9.61 634	9.95 931	9.65 703	0.34 297	0.04 069	0.38 366	**35**
26	.61 662	.95 925	.65 736	.34 264	.04 075	.38 338	34
27	.61 689	.95 920	.65 770	.34 230	.04 080	.38 311	33
28	.61 717	.95 914	.65 803	.34 197	.04 086	.38 283	32
29	.61 745	.95 908	.65 837	.34 163	.04 092	.38 255	31
30	9.61 773	9.95 902	9.65 870	0.34 130	0.04 098	0.38 227	**30**
31	.61 800	.95 897	.65 904	.34 096	.04 103	.38 200	29
32	.61 828	.95 891	.65 937	.34 063	.04 109	.38 172	28
33	.61 856	.95 885	.65 971	.34 029	.04 115	.38 144	27
34	.61 883	.95 879	.66 004	.33 996	.04 121	.38 117	26
35	9.61 911	9.95 873	9.66 038	0.33 962	0.04 127	0.38 089	**25**
36	.61 939	.95 868	.66 071	.33 929	.04 132	.38 061	24
37	.61 966	.95 862	.66 104	.33 896	.04 138	.38 034	23
38	.61 994	.95 856	.66 138	.33 862	.04 144	.38 006	22
39	.62 021	.95 850	.66 171	.33 829	.04 150	.37 979	21
40	9.62 049	9.95 844	9.66 204	0.33 796	0.04 156	0.37 951	**20**
41	.62 076	.95 839	.66 238	.33 762	.04 161	.37 924	19
42	.62 104	.95 833	.66 271	.33 729	.04 167	.37 896	18
43	.62 131	.95 827	.66 304	.33 696	.04 173	.37 869	17
44	.62 159	.95 821	.66 337	.33 663	.04 179	.37 841	16
45	9.62 186	9.95 815	9.66 371	0.33 629	0.04 185	0.37 814	**15**
46	.62 214	.95 810	.66 404	.33 596	.04 190	.37 786	14
47	.62 241	.95 804	.66 437	.33 563	.04 196	.37 759	13
48	.62 268	.95 798	.66 470	.33 530	.04 202	.37 732	12
49	.62 296	.95 792	.66 503	.33 497	.04 208	.37 704	11
50	9.62 323	9.95 786	9.66 537	0.33 463	0.04 214	0.37 677	**10**
51	.62 350	.95 780	.66 570	.33 430	.04 220	.37 650	9
52	.62 377	.95 775	.66 603	.33 397	.04 225	.37 623	8
53	.62 405	.95 769	.66 636	.33 364	.04 231	.37 595	7
54	.62 432	.95 763	.66 669	.33 331	.04 237	.37 568	6
55	9.62 459	9.95 757	9.66 702	0.33 298	0.04 243	0.37 541	**5**
56	.62 486	.95 751	.66 735	.33 265	.04 249	.37 514	4
57	.62 513	.95 745	.66 768	.33 232	.04 255	.37 487	3
58	.62 541	.95 739	.66 801	.33 199	.04 261	.37 459	2
59	.62 568	.95 733	.66 834	.33 166	.04 267	.37 432	1
60	9.62 595	9.95 728	9.66 867	0.33 133	0.04 272	0.37 405	**0**
	Cos	**Sin**	**Cot**	**Tan**	**Csc**	**Sec**	′

114° (294°) (245°) **65°**

25° (205°) (334°) **154°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.62 595	9.95 728	9.66 867	0.33 133	0.04 272	0.37 405	**60**
1	.62 622	.95 722	.66 900	.33 100	.04 278	.37 378	59
2	.62 649	.95 716	.66 933	.33 067	.04 284	.37 351	58
3	.62 676	.95 710	.66 966	.33 034	.04 290	.37 324	57
4	.62 703	.95 704	.66 999	.33 001	.04 296	.37 297	56
5	9.62 730	9.95 698	9.67 032	0.32 968	0.04 302	0.37 270	**55**
6	.62 757	.95 692	.67 065	.32 935	.04 308	.37 243	54
7	.62 784	.95 686	.67 098	.32 902	.04 314	.37 216	53
8	.62 811	.95 680	.67 131	.32 869	.04 320	.37 189	52
9	.62 838	.95 674	.67 163	.32 837	.04 326	.37 162	51
10	9.62 865	9.95 668	9.67 196	0.32 804	0.04 332	0.37 135	**50**
11	.62 892	.95 663	.67 229	.32 771	.04 337	.37 108	49
12	.62 918	.95 657	.67 262	.32 738	.04 343	.37 082	48
13	.62 945	.95 651	.67 295	.32 705	.04 349	.37 055	47
14	.62 972	.95 645	.67 327	.32 673	.04 355	.37 028	46
15	9.62 999	9.95 639	9.67 360	0.32 640	0.04 361	0.37 001	**45**
16	.63 026	.95 633	.67 393	.32 607	.04 367	.36 974	44
17	.63 052	.95 627	.67 426	.32 574	.04 373	.36 948	43
18	.63 079	.95 621	.67 458	.32 542	.04 379	.36 921	42
19	.63 106	.95 615	.67 491	.32 509	.04 385	.36 894	41
20	9.63 133	9.95 609	9.67 524	0.32 476	0.04 391	0.36 867	**40**
21	.63 159	.95 603	.67 556	.32 444	.04 397	.36 841	39
22	.63 186	.95 597	.67 589	.32 411	.04 403	.36 814	38
23	.63 213	.95 591	.67 622	.32 378	.04 409	.36 787	37
24	.63 239	.95 585	.67 654	.32 346	.04 415	.36 761	36
25	9.63 266	9.95 579	9.67 687	0.32 313	0.04 421	0.36 734	**35**
26	.63 292	.95 573	.67 719	.32 281	.04 427	.36 708	34
27	.63 319	.95 567	.67 752	.32 248	.04 433	.36 681	33
28	.63 345	.95 561	.67 785	.32 215	.04 439	.36 655	32
29	.63 372	.95 555	.67 817	.32 183	.04 445	.36 628	31
30	9.63 398	9.95 549	9.67 850	0.32 150	0.04 451	0.36 602	**30**
31	.63 425	.95 543	.67 882	.32 118	.04 457	.36 575	29
32	.63 451	.95 537	.67 915	.32 085	.04 463	.36 549	28
33	.63 478	.95 531	.67 947	.32 053	.04 469	.36 522	27
34	.63 504	.95 525	.67 980	.32 020	.04 475	.36 496	26
35	9.63 531	9.95 519	9.68 012	0.31 988	0.04 481	0.36 469	**25**
36	.63 557	.95 513	.68 044	.31 956	.04 487	.36 443	24
37	.63 583	.95 507	.68 077	.31 923	.04 493	.36 417	23
38	.63 610	.95 500	.68 109	.31 891	.04 500	.36 390	22
39	.63 636	.95 494	.68 142	.31 858	.04 506	.36 364	21
40	9.63 662	9.95 488	9.68 174	0.31 826	0.04 512	0.36 338	**20**
41	.63 689	.95 482	.68 206	.31 794	.04 518	.36 311	19
42	.63 715	.95 476	.68 239	.31 761	.04 524	.36 285	18
43	.63 741	.95 470	.68 271	.31 729	.04 530	.36 259	17
44	.63 767	.95 464	.68 303	.31 697	.04 536	.36 233	16
45	9.63 794	9.95 458	9.68 336	0.31 664	0.04 542	0.36 206	**15**
46	.63 820	.95 452	.68 368	.31 632	.04 548	.36 180	14
47	.63 846	.95 446	.68 400	.31 600	.04 554	.36 154	13
48	.63 872	.95 440	.68 432	.31 568	.04 560	.36 128	12
49	.63 898	.95 434	.68 465	.31 535	.04 566	.36 102	11
50	9.63 924	9.95 427	9.68 497	0.31 503	0.04 573	0.36 076	**10**
51	.63 950	.95 421	.68 529	.31 471	.04 579	.36 050	9
52	.63 976	.95 415	.68 561	.31 439	.04 585	.36 024	8
53	.64 002	.95 409	.68 593	.31 407	.04 591	.35 998	7
54	.64 028	.95 403	.68 626	.31 374	.04 597	.35 972	6
55	9.64 054	9.95 397	9.68 658	0.31 342	0.04 603	0.35 946	**5**
56	.64 080	.95 391	.68 690	.31 310	.04 609	.35 920	4
57	.64 106	.95 384	.68 722	.31 278	.04 616	.35 894	3
58	.64 132	.95 378	.68 754	.31 246	.04 622	.35 868	2
59	.64 158	.95 372	.68 786	.31 214	.04 628	.35 842	1
60	9.64 184	9.95 366	9.68 818	0.31 182	0.04 634	0.35 816	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

115° (295°) (244°) **64°**

26° (206°) | (333°) **153°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.64 184	9.95 366	9.68 818	0.31 182	0.04 634	0.35 816	**60**
1	.64 210	.95 360	.68 850	.31 150	.04 640	.35 790	59
2	.64 236	.95 354	.68 882	.31 118	.04 646	.35 764	58
3	.64 262	.95 348	.68 914	.31 086	.04 652	.35 738	57
4	.64 288	.95 341	.68 946	.31 054	.04 659	.35 712	56
5	9.64 313	9.95 335	9.68 978	0.31 022	0.04 665	0.35 687	**55**
6	.64 339	.95 329	.69 010	.30 990	.04 671	.35 661	54
7	.64 365	.95 323	.69 042	.30 958	.04 677	.35 635	53
8	.64 391	.95 317	.69 074	.30 926	.04 683	.35 609	52
9	.64 417	.95 310	.69 106	.30 894	.04 690	.35 583	51
10	9.64 442	9.95 304	9.69 138	0.30 862	0.04 696	0.35 558	**50**
11	.64 468	.95 298	.69 170	.30 830	.04 702	.35 532	49
12	.64 494	.95 292	.69 202	.30 798	.04 708	.35 506	48
13	.64 519	.95 286	.69 234	.30 766	.04 714	.35 481	47
14	.64 545	.95 279	.69 266	.30 734	.04 721	.35 455	46
15	9.64 571	9.95 273	9.69 298	0.30 702	0.04 727	0.35 429	**45**
16	.64 596	.95 267	.69 329	.30 671	.04 733	.35 404	44
17	.64 622	.95 261	.69 361	.30 639	.04 739	.35 378	43
18	.64 647	.95 254	.69 393	.30 607	.04 746	.35 353	42
19	.64 673	.95 248	.69 425	.30 575	.04 752	.35 327	41
20	9.64 698	9.95 242	9.69 457	0.30 543	0.04 758	0.35 302	**40**
21	.64 724	.95 236	.69 488	.30 512	.04 764	.35 276	39
22	.64 749	.95 229	.69 520	.30 480	.04 771	.35 251	38
23	.64 775	.95 223	.69 552	.30 448	.04 777	.35 225	37
24	.64 800	.95 217	.69 584	.30 416	.04 783	.35 200	36
25	9.64 826	9.95 211	9.69 615	0.30 385	0.04 789	0.35 174	**35**
26	.64 851	.95 204	.69 647	.30 353	.04 796	.35 149	34
27	.64 877	.95 198	.69 679	.30 321	.04 802	.35 123	33
28	.64 902	.95 192	.69 710	.30 290	.04 808	.35 098	32
29	.64 927	.95 185	.69 742	.30 258	.04 815	.35 073	31
30	9.64 953	9.95 179	9.69 774	0.30 226	0.04 821	0.35 047	**30**
31	.64 978	.95 173	.69 805	.30 195	.04 827	.35 022	29
32	.65 003	.95 167	.69 837	.30 163	.04 833	.34 997	28
33	.65 029	.95 160	.69 868	.30 132	.04 840	.34 971	27
34	.65 054	.95 154	.69 900	.30 100	.04 846	.34 946	26
35	9.65 079	9.95 148	9.69 932	0.30 068	0.04 852	0.34 921	**25**
36	.65 104	.95 141	.69 963	.30 037	.04 859	.34 896	24
37	.65 130	.95 135	.69 995	.30 005	.04 865	.34 870	23
38	.65 155	.95 129	.70 026	.29 974	.04 871	.34 845	22
39	.65 180	.95 122	.70 058	.29 942	.04 878	.34 820	21
40	9.65 205	9.95 116	9.70 089	0.29 911	0.04 884	0.34 795	**20**
41	.65 230	.95 110	.70 121	.29 879	.04 890	.34 770	19
42	.65 255	.95 103	.70 152	.29 848	.04 897	.34 745	18
43	.65 281	.95 097	.70 184	.29 816	.04 903	.34 719	17
44	.65 306	.95 090	.70 215	.29 785	.04 910	.34 694	16
45	9.65 331	9.95 084	9.70 247	0.29 753	0.04 916	0.34 669	**15**
46	.65 356	.95 078	.70 278	.29 722	.04 922	.34 644	14
47	.65 381	.95 071	.70 309	.29 691	.04 929	.34 619	13
48	.65 406	.95 065	.70 341	.29 659	.04 935	.34 594	12
49	.65 431	.95 059	.70 372	.29 628	.04 941	.34 569	11
50	9.65 456	9.95 052	9.70 404	0.29 596	0.04 948	0.34 544	**10**
51	.65 481	.95 046	.70 435	.29 565	.04 954	.34 519	9
52	.65 506	.95 039	.70 466	.29 534	.04 961	.34 494	8
53	.65 531	.95 033	.70 498	.29 502	.04 967	.34 469	7
54	.65 556	.95 027	.70 529	.29 471	.04 973	.34 444	6
55	9.65 580	9.95 020	9.70 560	0.29 440	0.04 980	0.34 420	**5**
56	.65 605	.95 014	.70 592	.29 408	.04 986	.34 395	4
57	.65 630	.95 007	.70 623	.29 377	.04 993	.34 370	3
58	.65 655	.95 001	.70 654	.29 346	.04 999	.34 345	2
59	.65 680	.94 995	.70 685	.29 315	.05 005	.34 320	1
60	9.65 705	9.94 988	9.70 717	0.29 283	0.05 012	0.34 295	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

116° (296°) | (243°) **63°**

27° (207°) (332°) **152°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.65 705	9.94 988	9.70 717	0.29 283	0.05 012	0.34 295	**60**
1	.65 729	.94 982	.70 748	.29 252	.05 018	.34 271	59
2	.65 754	.94 975	.70 779	.29 221	.05 025	.34 246	58
3	.65 779	.94 969	.70 810	.29 190	.05 031	.34 221	57
4	.65 804	.94 962	.70 841	.29 159	.05 038	.34 196	56
5	9.65 828	9.94 956	9.70 873	0.29 127	0.05 044	0.34 172	**55**
6	.65 853	.94 949	.70 904	.29 096	.05 051	.34 147	54
7	.65 878	.94 943	.70 935	.29 065	.05 057	.34 122	53
8	.65 902	.94 936	.70 966	.29 034	.05 064	.34 098	52
9	.65 927	.94 930	.70 997	.29 003	.05 070	.34 073	51
10	9.65 952	9.94 923	9.71 028	0.28 972	0.05 077	0.34 048	**50**
11	.65 976	.94 917	.71 059	.28 941	.05 083	.34 024	49
12	.66 001	.94 911	.71 090	.28 910	.05 089	.33 999	48
13	.66 025	.94 904	.71 121	.28 879	.05 096	.33 975	47
14	.66 050	.94 898	.71 153	.28 847	.05 102	.33 950	46
15	9.66 075	9.94 891	9.71 184	0.28 816	0.05 109	0.33 925	**45**
16	.66 099	.94 885	.71 215	.28 785	.05 115	.33 901	44
17	.66 124	.94 878	.71 246	.28 754	.05 122	.33 876	43
18	.66 148	.94 871	.71 277	.28 723	.05 129	.33 852	42
19	.66 173	.94 865	.71 308	.28 692	.05 135	.33 827	41
20	9.66 197	9.94 858	9.71 339	0.28 661	0.05 142	0.33 803	**40**
21	.66 221	.94 852	.71 370	.28 630	.05 148	.33 779	39
22	.66 246	.94 845	.71 401	.28 599	.05 155	.33 754	38
23	.66 270	.94 839	.71 431	.28 569	.05 161	.33 730	37
24	.66 295	.94 832	.71 462	.28 538	.05 168	.33 705	36
25	9.66 319	9.94 826	9.71 493	0.28 507	0.05 174	0.33 681	**35**
26	.66 343	.94 819	.71 524	.28 476	.05 181	.33 657	34
27	.66 368	.94 813	.71 555	.28 445	.05 187	.33 632	33
28	.66 392	.94 806	.71 586	.28 414	.05 194	.33 608	32
29	.66 416	.94 799	.71 617	.28 383	.05 201	.33 584	31
30	9.66 441	9.94 793	9.71 648	0.28 352	0.05 207	0.33 559	**30**
31	.66 465	.94 786	.71 679	.28 321	.05 214	.33 535	29
32	.66 489	.94 780	.71 709	.28 291	.05 220	.33 511	28
33	.66 513	.94 773	.71 740	.28 260	.05 227	.33 487	27
34	.66 537	.94 767	.71 771	.28 229	.05 233	.33 463	26
35	9.66 562	9.94 760	9.71 802	0.28 198	0.05 240	0.33 438	**25**
36	.66 586	.94 753	.71 833	.28 167	.05 247	.33 414	24
37	.66 610	.94 747	.71 863	.28 137	.05 253	.33 390	23
38	.66 634	.94 740	.71 894	.28 106	.05 260	.33 366	22
39	.66 658	.94 734	.71 925	.28 075	.05 266	.33 342	21
40	9.66 682	9.94 727	9.71 955	0.28 045	0.05 273	0.33 318	**20**
41	.66 706	.94 720	.71 986	.28 014	.05 280	.33 294	19
42	.66 731	.94 714	.72 017	.27 983	.05 286	.33 269	18
43	.66 755	.94 707	.72 048	.27 952	.05 293	.33 245	17
44	.66 779	.94 700	.72 078	.27 922	.05 300	.33 221	16
45	9.66 803	9.94 694	9.72 109	0.27 891	0.05 306	0.33 197	**15**
46	.66 827	.94 687	.72 140	.27 860	.05 313	.33 173	14
47	.66 851	.94 680	.72 170	.27 830	.05 320	.33 149	13
48	.66 875	.94 674	.72 201	.27 799	.05 326	.33 125	12
49	.66 899	.94 667	.72 231	.27 769	.05 333	.33 101	11
50	9.66 922	9.94 660	9.72 262	0.27 738	0.05 340	0.33 078	**10**
51	.66 946	.94 654	.72 293	.27 707	.05 346	.33 054	9
52	.66 970	.94 647	.72 323	.27 677	.05 353	.33 030	8
53	.66 994	.94 640	.72 354	.27 646	.05 360	.33 006	7
54	.67 018	.94 634	.72 384	.27 616	.05 366	.32 982	6
55	9.67 042	9.94 627	9.72 415	0.27 585	0.05 373	0.32 958	**5**
56	.67 066	.94 620	.72 445	.27 555	.05 380	.32 934	4
57	.67 090	.94 614	.72 476	.27 524	.05 386	.32 910	3
58	.67 113	.94 607	.72 506	.27 494	.05 393	.32 887	2
59	.67 137	.94 600	.72 537	.27 463	.05 400	.32 863	1
60	9.67 161	9.94 593	9.72 567	0.27 433	0.05 407	0.32 839	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

117° (297°) (242°) **62°**

28° (208°) (331°) **151°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.67 161	9.94 593	9.72 567	0.27 433	0.05 407	0.32 839	**60**
1	.67 185	.94 587	.72 598	.27 402	.05 413	.32 815	59
2	.67 208	.94 580	.72 628	.27 372	.05 420	.32 792	58
3	.67 232	.94 573	.72 659	.27 341	.05 427	.32 768	57
4	.67 256	.94 567	.72 689	.27 311	.05 433	.32 744	56
5	9.67 280	9.94 560	9.72 720	0.27 280	0.05 440	0.32 720	**55**
6	.67 303	.94 553	.72 750	.27 250	.05 447	.32 697	54
7	.67 327	.94 546	.72 780	.27 220	.05 454	.32 673	53
8	.67 350	.94 540	.72 811	.27 189	.05 460	.32 650	52
9	.67 374	.94 533	.72 841	.27 159	.05 467	.32 626	51
10	9.67 398	9.94 526	9.72 872	0.27 128	0.05 474	0.32 602	**50**
11	.67 421	.94 519	.72 902	.27 098	.05 481	.32 579	49
12	.67 445	.94 513	.72 932	.27 068	.05 487	.32 555	48
13	.67 468	.94 506	.72 963	.27 037	.05 494	.32 532	47
14	.67 492	.94 499	.72 993	.27 007	.05 501	.32 508	46
15	9.67 515	9.94 492	9.73 023	0.26 977	0.05 508	0.32 485	**45**
16	.67 539	.94 485	.73 054	.26 946	.05 515	.32 461	44
17	.67 562	.94 479	.73 084	.26 916	.05 521	.32 438	43
18	.67 586	.94 472	.73 114	.26 886	.05 528	.32 414	42
19	.67 609	.94 465	.73 144	.26 856	.05 535	.32 391	41
20	9.67 633	9.94 458	9.73 175	0.26 825	0.05 542	0.32 367	**40**
21	.67 656	.94 451	.73 205	.26 795	.05 549	.32 344	39
22	.67 680	.94 445	.73 235	.26 765	.05 555	.32 320	38
23	.67 703	.94 438	.73 265	.26 735	.05 562	.32 297	37
24	.67 726	.94 431	.73 295	.26 705	.05 569	.32 274	36
25	9.67 750	9.94 424	9.73 326	0.26 674	0.05 576	0.32 250	**35**
26	.67 773	.94 417	.73 356	.26 644	.05 583	.32 227	34
27	.67 796	.94 410	.73 386	.26 614	.05 590	.32 204	33
28	.67 820	.94 404	.73 416	.26 584	.05 596	.32 180	32
29	.67 843	.94 397	.73 446	.26 554	.05 603	.32 157	31
30	9.67 866	9.94 390	9.73 476	0.26 524	0.05 610	0.32 134	**30**
31	.67 890	.94 383	.73 507	.26 493	.05 617	.32 110	29
32	.67 913	.94 376	.73 537	.26 463	.05 624	.32 087	28
33	.67 936	.94 369	.73 567	.26 433	.05 631	.32 064	27
34	.67 959	.94 362	.73 597	.26 403	.05 638	.32 041	26
35	9.67 982	9.94 355	9.73 627	0.26 373	0.05 645	0.32 018	**25**
36	.68 006	.94 349	.73 657	.26 343	.05 651	.31 994	24
37	.68 029	.94 342	.73 687	.26 313	.05 658	.31 971	23
38	.68 052	.94 335	.73 717	.26 283	.05 665	.31 948	22
39	.68 075	.94 328	.73 747	.26 253	.05 672	.31 925	21
40	9.68 098	9.94 321	9.73 777	0.26 223	0.05 679	0.31 902	**20**
41	.68 121	.94 314	.73 807	.26 193	.05 686	.31 879	19
42	.68 144	.94 307	.73 837	.26 163	.05 693	.31 856	18
43	.68 167	.94 300	.73 867	.26 133	.05 700	.31 833	17
44	.68 190	.94 293	.73 897	.26 103	.05 707	.31 810	16
45	9.68 213	9.94 286	9.73 927	0.26 073	0.05 714	0.31 787	**15**
46	.68 237	.94 279	.73 957	.26 043	.05 721	.31 763	14
47	.68 260	.94 273	.73 987	.26 013	.05 727	.31 740	13
48	.68 283	.94 266	.74 017	.25 983	.05 734	.31 717	12
49	.68 305	.94 259	.74 047	.25 953	.05 741	.31 695	11
50	9.68 328	9.94 252	9.74 077	0.25 923	0.05 748	0.31 672	**10**
51	.68 351	.94 245	.74 107	.25 893	.05 755	.31 649	9
52	.68 374	.94 238	.74 137	.25 863	.05 762	.31 626	8
53	.68 397	.94 231	.74 166	.25 834	.05 769	.31 603	7
54	.68 420	.94 224	.74 196	.25 804	.05 776	.31 580	6
55	9.68 443	9.94 217	9.74 226	0.25 774	0.05 783	0.31 557	**5**
56	.68 466	.94 210	.74 256	.25 744	.05 790	.31 534	4
57	.68 489	.94 203	.74 286	.25 714	.05 797	.31 511	3
58	.68 512	.94 196	.74 316	.25 684	.05 804	.31 488	2
59	.68 534	.94 189	.74 345	.25 655	.05 811	.31 466	1
60	9.68 557	9.94 182	9.74 375	0.25 625	0.05 818	0.31 443	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

118° (298°) (241°) **61°**

29° (209°) (330°) 150°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.68 557	9.94 182	9.74 375	0.25 625	0.05 818	0.31 443	**60**
1	.68 580	.94 175	.74 405	.25 595	.05 825	.31 420	59
2	.68 603	.94 168	.74 435	.25 565	.05 832	.31 397	58
3	.68 625	.94 161	.74 465	.25 535	.05 839	.31 375	57
4	.68 648	.94 154	.74 494	.25 506	.05 846	.31 352	56
5	9.68 671	9.94 147	9.74 524	0.25 476	0.05 853	0.31 329	**55**
6	.68 694	.94 140	.74 554	.25 446	.05 860	.31 306	54
7	.68 716	.94 133	.74 583	.25 417	.05 867	.31 284	53
8	.68 739	.94 126	.74 613	.25 387	.05 874	.31 261	52
9	.68 762	.94 119	.74 643	.25 357	.05 881	.31 238	51
10	9.68 784	9.94 112	9.74 673	0.25 327	0.05 888	0.31 216	**50**
11	.68 807	.94 105	.74 702	.25 298	.05 895	.31 193	49
12	.68 829	.94 098	.74 732	.25 268	.05 902	.31 171	48
13	.68 852	.94 090	.74 762	.25 238	.05 910	.31 148	47
14	.68 875	.94 083	.74 791	.25 209	.05 917	.31 125	46
15	9.68 897	9.94 076	9.74 821	0.25 179	0.05 924	0.31 103	**45**
16	.68 920	.94 069	.74 851	.25 149	.05 931	.31 080	44
17	.68 942	.94 062	.74 880	.25 120	.05 938	.31 058	43
18	.68 965	.94 055	.74 910	.25 090	.05 945	.31 035	42
19	.68 987	.94 048	.74 939	.25 061	.05 952	.31 013	41
20	9.69 010	9.94 041	9.74 969	0.25 031	0.05 959	0.30 990	**40**
21	.69 032	.94 034	.74 998	.25 002	.05 966	.30 968	39
22	.69 055	.94 027	.75 028	.24 972	.05 973	.30 945	38
23	.69 077	.94 020	.75 058	.24 942	.05 980	.30 923	37
24	.69 100	.94 012	.75 087	.24 913	.05 988	.30 900	36
25	9.69 122	9.94 005	9.75 117	0.24 883	0.05 995	0.30 878	**35**
26	.69 144	.93 998	.75 146	.24 854	.06 002	.30 856	34
27	.69 167	.93 991	.75 176	.24 824	.06 009	.30 833	33
28	.69 189	.93 984	.75 205	.24 795	.06 016	.30 811	32
29	.69 212	.93 977	.75 235	.24 765	.06 023	.30 788	31
30	9.69 234	9.93 970	9.75 264	0.24 736	0.06 030	0.30 766	**30**
31	.69 256	.93 963	.75 294	.24 706	.06 037	.30 744	29
32	.69 279	.93 955	.75 323	.24 677	.06 045	.30 721	28
33	.69 301	.93 948	.75 353	.24 647	.06 052	.30 699	27
34	.69 323	.93 941	.75 382	.24 618	.06 059	.30 677	26
35	9.69 345	9.93 934	9.75 411	0.24 589	0.06 066	0.30 655	**25**
36	.69 368	.93 927	.75 441	.24 559	.06 073	.30 632	24
37	.69 390	.93 920	.75 470	.24 530	.06 080	.30 610	23
38	.69 412	.93 912	.75 500	.24 500	.06 088	.30 588	22
39	.69 434	.93 905	.75 529	.24 471	.06 095	.30 566	21
40	9.69 456	9.93 898	9.75 558	0.24 442	0.06 102	0.30 544	**20**
41	.69 479	.93 891	.75 588	.24 412	.06 109	.30 521	19
42	.69 501	.93 884	.75 617	.24 383	.06 116	.30 499	18
43	.69 523	.93 876	.75 647	.24 353	.06 124	.30 477	17
44	.69 545	.93 869	.75 676	.24 324	.06 131	.30 455	16
45	9.69 567	9.93 862	9.75 705	0.24 295	0.06 138	0.30 433	**15**
46	.69 589	.93 855	.75 735	.24 265	.06 145	.30 411	14
47	.69 611	.93 847	.75 764	.24 236	.06 153	.30 389	13
48	.69 633	.93 840	.75 793	.24 207	.06 160	.30 367	12
49	.69 655	.93 833	.75 822	.24 178	.06 167	.30 345	11
50	9.69 677	9.93 826	9.75 852	0.24 148	0.06 174	0.30 323	**10**
51	.69 699	.93 819	.75 881	.24 119	.06 181	.30 301	9
52	.69 721	.93 811	.75 910	.24 090	.06 189	.30 279	8
53	.69 743	.93 804	.75 939	.24 061	.06 196	.30 257	7
54	.69 765	.93 797	.75 969	.24 031	.06 203	.30 235	6
55	9.69 787	9.93 789	9.75 998	0.24 002	0.06 211	0.30 213	**5**
56	.69 809	.93 782	.76 027	.23 973	.06 218	.30 191	4
57	.69 831	.93 775	.76 056	.23 944	.06 225	.30 169	3
58	.69 853	.93 768	.76 086	.23 914	.06 232	.30 147	2
59	.69 875	.93 760	.76 115	.23 885	.06 240	.30 125	1
60	9.69 897	9.93 753	9.76 144	0.23 856	0.06 247	0.30 103	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

119° (299°) (240°) 60°

30° (210°) (329°) 149°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.69 897	9.93 753	9.76 144	0.23 856	0.06 247	0.30 103	**60**
1	.69 919	.93 746	.76 173	.23 827	.06 254	.30 081	59
2	.69 941	.93 738	.76 202	.23 798	.06 262	.30 059	58
3	.69 963	.93 731	.76 231	.23 769	.06 269	.30 037	57
4	.69 984	.93 724	.76 261	.23 739	.06 276	.30 016	56
5	9.70 006	9.93 717	9.76 290	0.23 710	0.06 283	0.29 994	**55**
6	.70 028	.93 709	.76 319	.23 681	.06 291	.29 972	54
7	.70 050	.93 702	.76 348	.23 652	.06 298	.29 950	53
8	.70 072	.93 695	.76 377	.23 623	.06 305	.29 928	52
9	.70 093	.93 687	.76 406	.23 594	.06 313	.29 907	51
10	9.70 115	9.93 680	9.76 435	0.23 565	0.06 320	0.29 885	**50**
11	.70 137	.93 673	.76 464	.23 536	.06 327	.29 863	49
12	.70 159	.93 665	.76 493	.23 507	.06 335	.29 841	48
13	.70 180	.93 658	.76 522	.23 478	.06 342	.29 820	45
14	.70 202	.93 650	.76 551	.23 449	.06 350	.29 798	46
15	9.70 224	9.93 643	9.76 580	0.23 420	0.06 357	0.29 776	**45**
16	.70 245	.93 636	.76 609	.23 391	.06 364	.29 755	44
17	.70 267	.93 628	.76 639	.23 361	.06 372	.29 733	43
18	.70 288	.93 621	.76 668	.23 332	.06 379	.29 712	42
19	.70 310	.93 614	.76 697	.23 303	.06 386	.29 690	41
20	9.70 332	9.93 606	9.76 725	0.23 275	0.06 394	0.29 668	**40**
21	.70 353	.93 599	.76 754	.23 246	.06 401	.29 647	39
22	.70 375	.93 591	.76 783	.23 217	.06 409	.29 625	38
23	.70 396	.93 584	.76 812	.23 188	.06 416	.29 604	37
24	.70 418	.93 577	.76 841	.23 159	.06 423	.29 582	36
25	9.70 439	9.93 569	9.76 870	0.23 130	0.06 431	0.29 561	**35**
26	.70 461	.93 562	.76 899	.23 101	.06 438	.29 539	34
27	.70 482	.93 554	.76 928	.23 072	.06 446	.29 518	33
28	.70 504	.93 547	.76 957	.23 043	.06 453	.29 496	32
29	.70 525	.93 539	.76 986	.23 014	.06 461	.29 475	31
30	9.70 547	9.93 532	9.77 015	0.22 985	0.06 468	0.29 453	**30**
31	.70 568	.93 525	.77 044	.22 956	.06 475	.29 432	29
32	.70 590	.93 517	.77 073	.22 927	.06 483	.29 410	28
33	.70 611	.93 510	.77 101	.22 899	.06 490	.29 389	27
34	.70 633	.93 502	.77 130	.22 870	.06 498	.29 367	26
35	9.70 654	9.93 495	9.77 159	0.22 841	0.06 505	0.29 346	**25**
36	.70 675	.93 487	.77 188	.22 812	.06 513	.29 325	24
37	.70 697	.93 480	.77 217	.22 783	.06 520	.29 303	23
38	.70 718	.93 472	.77 246	.22 754	.06 528	.29 282	22
39	.70 739	.93 465	.77 274	.22 726	.06 535	.29 261	21
40	9.70 761	9.93 457	9.77 303	0.22 697	0.06 543	0.29 239	**20**
41	.70 782	.93 450	.77 332	.22 668	.06 550	.29 218	19
42	.70 803	.93 442	.77 361	.22 639	.06 558	.29 197	18
43	.70 824	.93 435	.77 390	.22 610	.06 565	.29 176	17
44	.70 846	.93 427	.77 418	.22 582	.06 573	.29 154	16
45	9.70 867	9.93 420	9.77 447	0.22 553	0.06 580	0.29 133	**15**
46	.70 888	.93 412	.77 476	.22 524	.06 588	.29 112	14
47	.70 909	.93 405	.77 505	.22 495	.06 595	.29 091	13
48	.70 931	.93 397	.77 533	.22 467	.06 603	.29 069	12
49	.70 952	.93 390	.77 562	.22 438	.06 610	.29 048	11
50	9.70 973	9.93 382	9.77 591	0.22 409	0.06 618	0.29 027	**10**
51	.70 994	.93 375	.77 619	.22 381	.06 625	.29 006	9
52	.71 015	.93 367	.77 648	.22 352	.06 633	.28 985	8
53	.71 036	.93 360	.77 677	.22 323	.06 640	.28 964	7
54	.71 058	.93 352	.77 706	.22 294	.06 648	.28 942	6
55	9.71 079	9.93 344	9.77 734	0.22 266	0.06 656	0.28 921	**5**
56	.71 100	.93 337	.77 763	.22 237	.06 663	.28 900	4
57	.71 121	.93 329	.77 791	.22 209	.06 671	.28 879	3
58	.71 142	.93 322	.77 820	.22 180	.06 678	.28 858	2
59	.71 163	.93 314	.77 849	.22 151	.06 686	.28 837	1
60	9.71 184	9.93 307	9.77 877	0.22 123	0.06 693	0.28 816	0
	Cos	Sin	Cot	Tan	Csc	Sec	′

120° (300°) (239°) 59°

31° (211°) (328°) **148°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.71 184	9.93 307	9.77 877	0.22 123	0.06 693	0.28 816	**60**
1	.71 205	.93 299	.77 906	.22 094	.06 701	.28 795	59
2	.71 226	.93 291	.77 935	.22 065	.06 709	.28 774	58
3	.71 247	.93 284	.77 963	.22 037	.06 716	.28 753	57
4	.71 268	.93 276	.77 992	.22 008	.06 724	.28 732	56
5	9.71 289	9.93 269	9.78 020	0.21 980	0.06 731	0.28 711	**55**
6	.71 310	.93 261	.78 049	.21 951	.06 739	.28 690	54
7	.71 331	.93 253	.78 077	.21 923	.06 747	.28 669	53
8	.71 352	.93 246	.78 106	.21 894	.06 754	.28 648	52
9	.71 373	.93 238	.78 135	.21 865	.06 762	.28 627	51
10	9.71 393	9.93 230	9.78 163	0.21 837	0.06 770	0.28 607	**50**
11	.71 414	.93 223	.78 192	.21 808	.06 777	.28 586	49
12	.71 435	.93 215	.78 220	.21 780	.06 785	.28 565	48
13	.71 456	.93 207	.78 249	.21 751	.06 793	.28 544	47
14	.71 477	.93 200	.78 277	.21 723	.06 800	.28 523	46
15	9.71 498	9.93 192	9.78 306	0.21 694	0.06 808	0.28 502	**45**
16	.71 519	.93 184	.78 334	.21 666	.06 816	.28 481	44
17	.71 539	.93 177	.78 363	.21 637	.06 823	.28 461	43
18	.71 560	.93 169	.78 391	.21 609	.06 831	.28 440	42
19	.71 581	.93 161	.78 419	.21 581	.06 839	.28 419	41
20	9.71 602	9.93 154	.78 448	0.21 552	0.06 846	0.28 398	**40**
21	.71 622	.93 146	.78 476	.21 524	.06 854	.28 378	39
22	.71 643	.93 138	.78 505	.21 495	.06 862	.28 357	38
23	.71 664	.93 131	.78 533	.21 467	.06 869	.28 336	37
24	.71 685	.93 123	.78 562	.21 438	.06 877	.28 315	36
25	9.71 705	9.93 115	9.78 590	0.21 410	0.06 885	0.28 295	**35**
26	.71 726	.93 108	.78 618	.21 382	.06 892	.28 274	34
27	.71 747	.93 100	.78 647	.21 353	.06 900	.28 253	33
28	.71 767	.93 092	.78 675	.21 325	.06 908	.28 233	32
29	.71 788	.93 084	.78 704	.21 296	.06 916	.28 212	31
30	9.71 809	9.93 077	9.78 732	0.21 268	0.06 923	0.28 191	**30**
31	.71 829	.93 069	.78 760	.21 240	.06 931	.28 171	29
32	.71 850	.93 061	.78 789	.21 211	.06 939	.28 150	28
33	.71 870	.93 053	.78 817	.21 183	.06 947	.28 130	27
34	.71 891	.93 046	.78 845	.21 155	.06 954	.28 109	26
35	9.71 911	9.93 038	9.78 874	0.21 126	0.06 962	0.28 089	**25**
36	.71 932	.93 030	.78 902	.21 098	.06 970	.28 068	24
37	.71 952	.93 022	.78 930	.21 070	.06 978	.28 048	23
38	.71 973	.93 014	.78 959	.21 041	.06 986	.28 027	22
39	.71 994	.93 007	.78 987	.21 013	.06 993	.28 006	21
40	9.72 014	9.92 999	9.79 015	0.20 985	0.07 001	0.27 986	**20**
41	.72 034	.92 991	.79 043	.20 957	.07 009	.27 966	19
42	.72 055	.92 983	.79 072	.20 928	.07 017	.27 945	18
43	.72 075	.92 976	.79 100	.20 900	.07 024	.27 925	17
44	.72 096	.92 968	.79 128	.20 872	.07 032	.27 904	16
45	9.72 116	9.92 960	9.79 156	0.20 844	0.07 040	0.27 884	**15**
46	.72 137	.92 952	.79 185	.20 815	.07 048	.27 863	14
47	.72 157	.92 944	.79 213	.20 787	.07 056	.27 843	13
48	.72 177	.92 936	.79 241	.20 759	.07 064	.27 823	12
49	.72 198	.92 929	.79 269	.20 731	.07 071	.27 802	11
50	9.72 218	9.92 921	9.79 297	0.20 703	0.07 079	0.27 782	**10**
51	.72 238	.92 913	.79 326	.20 674	.07 087	.27 762	9
52	.72 259	.92 905	.79 354	.20 646	.07 095	.27 741	8
53	.72 279	.92 897	.79 382	.20 618	.07 103	.27 721	7
54	.72 299	.92 889	.79 410	.20 590	.07 111	.27 701	6
55	9.72 320	9.92 881	9.79 438	0.20 562	0.07 119	0.27 680	**5**
56	.72 340	.92 874	.79 466	.20 534	.07 126	.27 660	4
57	.72 360	.92 866	.79 495	.20 505	.07 134	.27 640	3
58	.72 381	.92 858	.79 523	.20 477	.07 142	.27 619	2
59	.72 401	.92 850	.79 551	.20 449	.07 150	.27 599	1
60	9.72 421	9.92 842	9.79 579	0.20 421	0.07 158	0.27 579	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

121° (301°) (238°) **58°**

32° (212°) (327°) **147°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.72 421	9.92 842	9.79 579	0.20 421	0.07 158	0.27 579	**60**
1	.72 441	.92 834	.79 607	.20 393	.07 166	.27 559	59
2	.72 461	.92 826	.79 635	.20 365	.07 174	.27 539	58
3	.72 482	.92 818	.79 663	.20 337	.07 182	.27 518	57
4	.72 502	.92 810	.79 691	.20 309	.07 190	.27 498	56
5	9.72 522	9.92 803	9.79 719	0.20 281	0.07 197	0.27 478	**55**
6	.72 542	.92 795	.79 747	.20 253	.07 205	.27 458	54
7	.72 562	.92 787	.79 776	.20 224	.07 213	.27 438	53
8	.72 582	.92 779	.79 804	.20 196	.07 221	.27 418	52
9	.72 602	.92 771	.79 832	.20 168	.07 229	.27 398	51
10	9.72 622	9.92 763	9.79 860	0.20 140	0.07 237	0.27 378	**50**
11	.72 643	.92 755	.79 888	.20 112	.07 245	.27 357	49
12	.72 663	.92 747	.79 916	.20 084	.07 253	.27 337	48
13	.72 683	.92 739	.79 944	.20 056	.07 261	.27 317	47
14	.72 703	.92 731	.79 972	.20 028	.07 269	.27 297	46
15	9.72 723	9.92 723	9.80 000	0.20 000	0.07 277	0.27 277	**45**
16	.72 743	.92 715	.80 028	.19 972	.07 285	.27 257	44
17	.72 763	.92 707	.80 056	.19 944	.07 293	.27 237	43
18	.72 783	.92 699	.80 084	.19 916	.07 301	.27 217	42
19	.72 803	.92 691	.80 112	.19 888	.07 309	.27 197	41
20	9.72 823	9.92 683	9.80 140	0.19 860	0.07 317	0.27 177	**40**
21	.72 843	.92 675	.80 168	.19 832	.07 325	.27 157	39
22	.72 863	.92 667	.80 195	.19 805	.07 333	.27 137	38
23	.72 883	.92 659	.80 223	.19 777	.07 341	.27 117	37
24	.72 902	.92 651	.80 251	.19 749	.07 349	.27 098	36
25	9.72 922	9.92 643	9.80 279	0.19 721	0.07 357	0.27 078	**35**
26	.72 942	.92 635	.80 307	.19 693	.07 365	.27 058	34
27	.72 962	.92 627	.80 335	.19 665	.07 373	.27 038	33
28	.72 982	.92 619	.80 363	.19 637	.07 381	.27 018	32
29	.73 002	.92 611	.80 391	.19 609	.07 389	.26 998	31
30	9.73 022	0.92 603	9.80 419	0.19 581	0.07 397	0.26 978	**30**
31	.73 041	.92 595	.80 447	.19 553	.07 405	.26 959	29
32	.73 061	.92 587	.80 474	.19 526	.07 413	.26 939	28
33	.73 081	.92 579	.80 502	.19 498	.07 421	.26 919	27
34	.73 101	.92 571	.80 530	.19 470	.07 429	.26 899	26
35	9.73 121	9.92 563	9.80 558	0.19 442	0.07 437	0.26 879	**25**
36	.73 140	.92 555	.80 586	.19 414	.07 445	.26 860	24
37	.73 160	.92 546	.80 614	.19 386	.07 454	.26 840	23
38	.73 180	.92 538	.80 642	.19 358	.07 462	.26 820	22
39	.73 200	.92 530	.80 669	.19 331	.07 470	.26 800	21
40	9.73 219	9.92 522	9.80 697	0.19 303	0.07 478	0.26 781	**20**
41	.73 239	.92 514	.80 725	.19 275	.07 486	.26 761	19
42	.73 259	.92 506	.80 753	.19 247	.07 494	.26 741	18
43	.73 278	.92 498	.80 781	.19 219	.07 502	.26 722	17
44	.73 298	.92 490	.80 808	.19 192	.07 510	.26 702	16
45	9.73 318	9.92 482	9.80 836	0.19 164	0.07 518	0.26 682	**15**
46	.73 337	.92 473	.80 864	.19 136	.07 527	.26 663	14
47	.73 357	.92 465	.80 892	.19 108	.07 535	.26 643	13
48	.73 377	.92 457	.80 919	.19 081	.07 543	.26 623	12
49	.73 396	.92 449	.80 947	.19 053	.07 551	.26 604	11
50	9.73 416	9.92 441	9.80 975	0.19 025	0.07 559	0.26 584	**10**
51	.73 435	.92 433	.81 003	.18 997	.07 567	.26 565	9
52	.73 455	.92 425	.81 030	.18 970	.07 575	.26 545	8
53	.73 474	.92 416	.81 058	.18 942	.07 584	.26 526	7
54	.73 494	.92 408	.81 086	.18 914	.07 592	.26 506	6
55	9.73 513	9.92 400	9.81 113	0.18 887	0.07 600	0.26 487	**5**
56	.73 533	.92 392	.81 141	.18 859	.07 608	.26 467	4
57	.73 552	.92 384	.81 169	.18 831	.07 616	.26 448	3
58	.73 572	.92 376	.81 196	.18 804	.07 624	.26 428	2
59	.73 591	.92 367	.81 224	.18 776	.07 633	.26 409	1
60	9.73 611	9.92 359	9.81 252	0.18 748	0.07 641	0.26 389	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

122° (302°) (237°) **57°**

33° (213°) (326°) **146°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.73 611	9.92 359	9.81 252	0.18 748	0.07 641	0.26 389	**60**
1	.73 630	.92 351	.81 279	.18 721	.07 649	.26 370	59
2	.73 650	.92 343	.81 307	.18 693	.07 657	.26 350	58
3	.73 669	.92 335	.81 335	.18 665	.07 665	.26 331	57
4	.73 689	.92 326	.81 362	.18 638	.07 674	.26 311	56
5	9.73 708	9.92 318	9.81 390	0.18 610	0.07 682	0.26 292	**55**
6	.73 727	.92 310	.81 418	.18 582	.07 690	.26 273	54
7	.73 747	.92 302	.81 445	.18 555	.07 698	.26 253	53
8	.73 766	.92 293	.81 473	.18 527	.07 707	.26 234	52
9	.73 785	.92 285	.81 500	.18 500	.07 715	.26 215	51
10	9.73 805	9.92 277	9.81 528	0.18 472	0.07 723	0.26 195	**50**
11	.73 824	.92 269	.81 556	.18 444	.07 731	.26 176	49
12	.73 843	.92 260	.81 583	.18 417	.07 740	.26 157	48
13	.73 863	.92 252	.81 611	.18 389	.07 748	.26 137	47
14	.73 882	.92 244	.81 638	.18 362	.07 756	.26 118	46
15	9.73 901	9.92 235	9.81 666	0.18 334	0.07 765	0.26 099	**45**
16	.73 921	.92 227	.81 693	.18 307	.07 773	.26 079	44
17	.73 940	.92 219	.81 721	.18 279	.07 781	.26 060	43
18	.73 959	.92 211	.81 748	.18 252	.07 789	.26 041	42
19	.73 978	.92 202	.81 776	.18 224	.07 798	.26 022	41
20	9.73 997	9.92 194	9.81 803	0.18 197	0.07 806	0.26 003	**40**
21	.74 017	.92 186	.81 831	.18 169	.07 814	.25 983	39
22	.74 036	.92 177	.81 858	.18 142	.07 823	.25 964	38
23	.74 055	.92 169	.81 886	.18 114	.07 831	.25 945	37
24	.74 074	.92 161	.81 913	.18 087	.07 839	.25 926	36
25	9.74 093	9.92 152	9.81 941	0.18 059	0.07 848	0.25 907	**35**
26	.74 113	.92 144	.81 968	.18 032	.07 856	.25 887	34
27	.74 132	.92 136	.81 996	.18 004	.07 864	.25 868	33
28	.74 151	.92 127	.82 023	.17 977	.07 873	.25 849	32
29	.74 170	.92 119	.82 051	.17 949	.07 881	.25 830	31
30	9.74 189	9.92 111	9.82 078	0.17 922	0.07 889	0.25 811	**30**
31	.74 208	.92 102	.82 106	.17 894	.07 898	.25 792	29
32	.74 227	.92 094	.82 133	.17 867	.07 906	.25 773	28
33	.74 246	.92 086	.82 161	.17 839	.07 914	.25 754	27
34	.74 265	.92 077	.82 188	.17 812	.07 923	.25 735	26
35	9.74 284	9.92 069	9.82 215	0.17 785	0.07 931	0.25 716	**25**
36	.74 303	.92 060	.82 243	.17 757	.07 940	.25 697	24
37	.74 322	.92 052	.82 270	.17 730	.07 948	.25 678	23
38	.74 341	.92 044	.82 298	.17 702	.07 956	.25 659	22
39	.74 360	.92 035	.82 325	.17 675	.07 965	.25 640	21
40	9.74 379	9.92 027	9.82 352	0.17 648	0.07 973	0.25 621	**20**
41	.74 398	.92 018	.82 380	.17 620	.07 982	.25 602	19
42	.74 417	.92 010	.82 407	.17 593	.07 990	.25 583	18
43	.74 436	.92 002	.82 435	.17 565	.07 998	.25 564	17
44	.74 455	.91 993	.82 462	.17 538	.08 007	.25 545	16
45	9.74 474	9.91 985	9.82 489	0.17 511	0.08 015	0.25 526	**15**
46	.74 493	.91 976	.82 517	.17 483	.08 024	.25 507	14
47	.74 512	.91 968	.82 544	.17 456	.08 032	.25 488	13
48	.74 531	.91 959	.82 571	.17 429	.08 041	.25 469	12
49	.74 549	.91 951	.82 599	.17 401	.08 049	.25 451	11
50	9.74 568	9.91 942	9.82 626	0.17 374	0.08 058	0.25 432	**10**
51	.74 587	.91 934	.82 653	.17 347	.08 066	.25 413	9
52	.74 606	.91 925	.82 681	.17 319	.08 075	.25 394	8
53	.74 625	.91 917	.82 708	.17 292	.08 083	.25 375	7
54	.74 644	.91 908	.82 735	.17 265	.08 092	.25 356	6
55	9.74 662	9.91 900	9.82 762	0.17 238	0.08 100	0.25 338	**5**
56	.74 681	.91 891	.82 790	.17 210	.08 109	.25 319	4
57	.74 700	.91 883	.82 817	.17 183	.08 117	.25 300	3
58	.74 719	.91 874	.82 844	.17 156	.08 126	.25 281	2
59	.74 737	.91 866	.82 871	.17 129	.08 134	.25 263	1
60	9.74 756	9.91 857	9.82 899	0.17 101	0.08 143	0.25 244	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

123° (303°) (236°) **56°**

34° (214°) (325°) **145°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.74 756	9.91 857	9.82 899	0.17 101	0.08 143	0.25 244	**60**
1	.74 775	.91 849	.82 926	.17 074	.08 151	.25 225	59
2	.74 794	.91 840	.82 953	.17 047	.08 160	.25 206	58
3	.74 812	.91 832	.82 980	.17 020	.08 168	.25 188	57
4	.74 831	.91 823	.83 008	.16 992	.08 177	.25 169	56
5	9.74 850	9.91 815	9.83 035	0.16 965	0.08 185	0.25 150	**55**
6	.74 868	.91 806	.83 062	.16 938	.08 194	.25 132	54
7	.74 887	.91 798	.83 089	.16 911	.08 202	.25 113	53
8	.74 906	.91 789	.83 117	.16 883	.08 211	.25 094	52
9	.74 924	.91 781	.83 144	.16 856	.08 219	.25 076	51
10	9.74 943	9.91 772	9.83 171	0.16 829	0.08 228	0.25 057	**50**
11	.74 961	.91 763	.83 198	.16 802	.08 237	.25 039	49
12	.74 980	.91 755	.83 225	.16 775	.08 245	.25 020	48
13	.74 999	.91 746	.83 252	.16 748	.08 254	.25 001	47
14	.75 017	.91 738	.83 280	.16 720	.08 262	.24 983	46
15	9.75 036	9.91 729	9.83 307	0.16 693	0.08 271	0.24 964	**45**
16	.75 054	.91 720	.83 334	.16 666	.08 280	.24 946	44
17	.75 073	.91 712	.83 361	.16 639	.08 288	.24 927	43
18	.75 091	.91 703	.83 388	.16 612	.08 297	.24 909	42
19	.75 110	.91 695	.83 415	.16 585	.08 305	.24 890	41
20	9.75 128	9.91 686	9.83 442	0.16 558	0.08 314	0.24 872	**40**
21	.75 147	.91 677	.83 470	.16 530	.08 323	.24 853	39
22	.75 165	.91 669	.83 497	.16 503	.08 331	.24 835	38
23	.75 184	.91 660	.83 524	.16 476	.08 340	.24 816	37
24	.75 202	.91 651	.83 551	.16 449	.08 349	.24 798	36
25	9.75 221	9.91 643	9.83 578	0.16 422	0.08 357	0.24 779	**35**
26	.75 239	.91 634	.83 605	.16 395	.08 366	.24 761	34
27	.75 258	.91 625	.83 632	.16 368	.08 375	.24 742	33
28	.75 276	.91 617	.83 659	.16 341	.08 383	.24 724	32
29	.75 294	.91 608	.83 686	.16 314	.08 392	.24 706	31
30	9.75 313	9.91 599	9.83 713	0.16 287	0.08 401	0.24 687	**30**
31	.75 331	.91 591	.83 740	.16 260	.08 409	.24 669	29
32	.75 350	.91 582	.83 768	.16 232	.08 418	.24 650	28
33	.75 368	.91 573	.83 795	.16 205	.08 427	.24 632	27
34	.75 386	.91 565	.83 822	.16 178	.08 435	.24 614	26
35	9.75 405	9.91 556	9.83 849	0.16 151	0.08 444	0.24 595	**25**
36	.75 423	.91 547	.83 876	.16 124	.08 453	.24 577	24
37	.75 441	.91 538	.83 903	.16 097	.08 462	.24 559	23
38	.75 459	.91 530	.83 930	.16 070	.08 470	.24 541	22
39	.75 478	.91 521	.83 957	.16 043	.08 479	.24 522	21
40	9.75 496	9.91 512	9.83 984	0.16 016	0.08 488	0.24 504	**20**
41	.75 514	.91 504	.84 011	.15 989	.08 496	.24 486	19
42	.75 533	.91 495	.84 038	.15 962	.08 505	.24 467	18
43	.75 551	.91 486	.84 065	.15 935	.08 514	.24 449	17
44	.75 569	.91 477	.84 092	.15 908	.08 523	.24 431	16
45	9.75 587	9.91 469	9.84 119	0.15 881	0.08 531	0.24 413	**15**
46	.75 605	.91 460	.84 146	.15 854	.08 540	.24 395	14
47	.75 624	.91 451	.84 173	.15 827	.08 549	.24 376	13
48	.75 642	.91 442	.84 200	.15 800	.08 558	.24 358	12
49	.75 660	.91 433	.84 227	.15 773	.08 567	.24 340	11
50	9.75 678	9.91 425	9.84 254	0.15 746	0.08 575	0.24 322	**10**
51	.75 696	.91 416	.84 280	.15 720	.08 584	.24 304	9
52	.75 714	.91 407	.84 307	.15 693	.08 593	.24 286	8
53	.75 733	.91 398	.84 334	.15 666	.08 602	.24 267	7
54	.75 751	.91 389	.84 361	.15 639	.08 611	.24 249	6
55	9.75 769	9.91 381	9.84 388	0.15 612	0.08 619	0.24 231	**5**
56	.75 787	.91 372	.84 415	.15 585	.08 628	.24 213	4
57	.75 805	.91 363	.84 442	.15 558	.08 637	.24 195	3
58	.75 823	.91 354	.84 469	.15 531	.08 646	.24 177	2
59	.75 841	.91 345	.84 496	.15 504	.08 655	.24 159	1
60	9.75 859	9.91 336	9.84 523	0.15 477	0.08 664	0.24 141	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

124° (304°) (235°) **55°**

35° (215°) (324°) **144°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.75 859	9.91 336	9.84 523	0.15 477	0.08 664	0.24 141	**60**
1	.75 877	.91 328	.84 550	.15 450	.08 672	.24 123	59
2	.75 895	.91 319	.84 576	.15 424	.08 681	.24 105	58
3	.75 913	.91 310	.84 603	.15 397	.08 690	.24 087	57
4	.75 931	.91 301	.84 630	.15 370	.08 699	.24 069	56
5	9.75 949	9.91 292	9.84 657	0.15 343	0.08 708	0.24 051	**55**
6	.75 967	.91 283	.84 684	.15 316	.08 717	.24 033	54
7	.75 985	.91 274	.84 711	.15 289	.08 726	.24 015	53
8	.76 003	.91 266	.84 738	.15 262	.08 734	.23 997	52
9	.76 021	.91 257	.84 764	.15 236	.08 743	.23 979	51
10	9.76 039	9.91 248	9.84 791	0.15 209	0.08 752	0.23 961	**50**
11	.76 057	.91 239	.84 818	.15 182	.08 761	.23 943	49
12	.76 075	.91 230	.84 845	.15 155	.08 770	.23 925	48
13	.76 093	.91 221	.84 872	.15 128	.08 779	.23 907	47
14	.76 111	.91 212	.84 899	.15 101	.08 788	.23 889	46
15	9.76 129	9.91 203	9.84 925	0.15 075	0.08 797	0.23 871	**45**
16	.76 146	.91 194	.84 952	.15 048	.08 806	.23 854	44
17	.76 164	.91 185	.84 979	.15 021	.08 815	.23 836	43
18	.76 182	.91 176	.85 006	.14 994	.08 824	.23 818	42
19	.76 200	.91 167	.85 033	.14 967	.08 833	.23 800	41
20	9.76 218	9.91 158	9.85 059	0.14 941	0.08 842	0.23 782	**40**
21	.76 236	.91 149	.85 086	.14 914	.08 851	.23 764	39
22	.76 253	.91 141	.85 113	.14 887	.08 859	.23 747	38
23	.76 271	.91 132	.85 140	.14 860	.08 868	.23 729	37
24	.76 289	.91 123	.85 166	.14 834	.08 877	.23 711	36
25	9.76 307	9.91 114	9.85 193	0.14 807	0.08 886	0.23 693	**35**
26	.76 324	.91 105	.85 220	.14 780	.08 895	.23 676	34
27	.76 342	.91 096	.85 247	.14 753	.08 904	.23 658	33
28	.76 360	.91 087	.85 273	.14 727	.08 913	.23 640	32
29	.76 378	.91 078	.85 300	.14 700	.08 922	.23 622	31
30	9.76 395	9.91 069	9.85 327	0.14 673	0.08 931	0.23 605	**30**
31	.76 413	.91 060	.85 354	.14 646	.08 940	.23 587	29
32	.76 431	.91 051	.85 380	.14 620	.08 949	.23 569	28
33	.76 448	.91 042	.85 407	.14 593	.08 958	.23 552	27
34	.76 466	.91 033	.85 434	.14 566	.08 967	.23 534	26
35	9.76 484	9.91 023	9.85 460	0.14 540	0.08 977	0.23 516	**25**
36	.76 501	.91 014	.85 487	.14 513	.08 986	.23 499	24
37	.76 519	.91 005	.85 514	.14 486	.08 995	.23 481	23
38	.76 537	.90 996	.85 540	.14 460	.09 004	.23 463	22
39	.76 554	.90 987	.85 567	.14 433	.09 013	.23 446	21
40	9.76 572	9.90 978	9.85 594	0.14 406	0.09 022	0.23 428	**20**
41	.76 590	.90 969	.85 620	.14 380	.09 031	.23 410	19
42	.76 607	.90 960	.85 647	.14 353	.09 040	.23 393	18
43	.76 625	.90 951	.85 674	.14 326	.09 049	.23 375	17
44	.76 642	.90 942	.85 700	.14 300	.09 058	.23 358	16
45	9.76 660	9.90 933	9.85 727	0.14 273	0.09 067	0.23 340	**15**
46	.76 677	.90 924	.85 754	.14 246	.09 076	.23 323	14
47	.76 695	.90 915	.85 780	.14 220	.09 085	.23 305	13
48	.76 712	.90 906	.85 807	.14 193	.09 094	.23 288	12
49	.76 730	.90 896	.85 834	.14 166	.09 104	.23 270	11
50	9.76 747	9.90 887	9.85 860	0.14 140	0.09 113	0.23 253	**10**
51	.76 765	.90 878	.85 887	.14 113	.09 122	.23 235	9
52	.76 782	.90 869	.85 913	.14 087	.09 131	.23 218	8
53	.76 800	.90 860	.85 940	.14 060	.09 140	.23 200	7
54	.76 817	.90 851	.85 967	.14 033	.09 149	.23 183	6
55	9.76 835	9.90 842	9.85 993	0.14 007	0.09 158	0.23 165	**5**
56	.76 852	.90 832	.86 020	.13 980	.09 168	.23 148	4
57	.76 870	.90 823	.86 046	.13 954	.09 177	.23 130	3
58	.76 887	.90 814	.86 073	.13 927	.09 186	.23 113	2
59	.76 904	.90 805	.86 100	.13 900	.09 195	.23 096	1
60	9.76 922	9.90 796	9.86 126	0.13 874	0.09 204	0.23 078	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

125° (305°) (234°) **54°**

36° (216°) (323°) 143°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.76 922	9.90 796	9.86 126	0.13 874	0.09 204	0.23 078	**60**
1	.76 939	.90 787	.86 153	.13 847	.09 213	.23 061	59
2	.76 957	.90 777	.86 179	.13 821	.09 223	.23 043	58
3	.76 974	.90 768	.86 206	.13 794	.09 232	.23 026	57
4	.76 991	.90 759	.86 232	.13 768	.09 241	.23 009	56
5	9.77 009	9.90 750	9.86 259	0.13 741	0.09 250	0.22 991	**55**
6	.77 026	.90 741	.86 285	.13 715	.09 259	.22 974	54
7	.77 043	.90 731	.86 312	.13 688	.09 269	.22 957	53
8	.77 061	.90 722	.86 338	.13 662	.09 278	.22 939	52
9	.77 078	.90 713	.86 365	.13 635	.09 287	.22 922	51
10	9.77 095	9.90 704	9.86 392	0.13 608	0.09 296	0.22 905	**50**
11	.77 112	.90 694	.86 418	.13 582	.09 306	.22 888	49
12	.77 130	.90 685	.86 445	.13 555	.09 315	.22 870	48
13	.77 147	.90 676	.86 471	.13 529	.09 324	.22 853	47
14	.77 164	.90 667	.86 498	.13 502	.09 333	.22 836	46
15	9.77 181	9.90 657	9.86 524	0.13 476	0.09 343	0.22 819	**45**
16	.77 199	.90 648	.86 551	.13 449	.09 352	.22 801	44
17	.77 216	.90 639	.86 577	.13 423	.09 361	.22 784	43
18	.77 233	.90 630	.86 603	.13 397	.09 370	.22 767	42
19	.77 250	.90 620	.86 630	.13 370	.09 380	.22 750	41
20	9.77 268	9.90 611	9.86 656	0.13 344	0.09 389	0.22 732	**40**
21	.77 285	.90 602	.86 683	.13 317	.09 398	.22 715	39
22	.77 302	.90 592	.86 709	.13 291	.09 408	.22 698	38
23	.77 319	.90 583	.86 736	.13 264	.09 417	.22 681	37
24	.77 336	.90 574	.86 762	.13 238	.09 426	.22 664	36
25	9.77 353	9.90 565	9.86 789	0.13 211	0.09 435	0.22 647	**35**
26	.77 370	.90 555	.86 815	.13 185	.09 445	.22 630	34
27	.77 387	.90 546	.86 842	.13 158	.09 454	.22 613	33
28	.77 405	.90 537	.86 868	.13 132	.09 463	.22 595	32
29	.77 422	.90 527	.86 894	.13 106	.09 473	.22 578	31
30	9.77 439	9.90 518	9.86 921	0.13 079	0.09 482	0.22 561	**30**
31	.77 456	.90 509	.86 947	.13 053	.09 491	.22 544	29
32	.77 473	.90 499	.86 974	.13 026	.09 501	.22 527	28
33	.77 490	.90 490	.87 000	.13 000	.09 510	.22 510	27
34	.77 507	.90 480	.87 027	.12 973	.09 520	.22 493	26
35	9.77 524	9.90 471	9.87 053	0.12 947	0.09 529	0.22 476	**25**
36	.77 541	.90 462	.87 079	.12 921	.09 538	.22 459	24
37	.77 558	.90 452	.87 106	.12 894	.09 548	.22 442	23
38	.77 575	.90 443	.87 132	.12 868	.09 557	.22 425	22
39	.77 592	.90 434	.87 158	.12 842	.09 566	.22 408	21
40	9.77 609	9.90 424	9.87 185	0.12 815	0.09 576	0.22 391	**20**
41	.77 626	.90 415	.87 211	.12 789	.09 585	.22 374	19
42	.77 643	.90 405	.87 238	.12 762	.09 595	.22 357	18
43	.77 660	.90 396	.87 264	.12 736	.09 604	.22 340	17
44	.77 677	.90 386	.87 290	.12 710	.09 614	.22 323	16
45	9.77 694	9.90 377	9.87 317	0.12 683	0.09 623	0.22 306	**15**
46	.77 711	.90 368	.87 343	.12 657	.09 632	.22 289	14
47	.77 728	.90 358	.87 369	.12 631	.09 642	.22 272	13
48	.77 744	.90 349	.87 396	.12 604	.09 651	.22 256	12
49	.77 761	.90 339	.87 422	.12 578	.09 661	.22 239	11
50	9.77 778	9.90 330	9.87 448	0.12 552	0.09 670	0.22 222	**10**
51	.77 795	.90 320	.87 475	.12 525	.09 680	.22 205	9
52	.77 812	.90 311	.87 501	.12 499	.09 689	.22 188	8
53	.77 829	.90 301	.87 527	.12 473	.09 699	.22 171	7
54	.77 846	.90 292	.87 554	.12 446	.09 708	.22 154	6
55	9.77 862	9.90 282	9.87 580	0.12 420	0.09 718	0.22 138	**5**
56	.77 879	.90 273	.87 606	.12 394	.09 727	.22 121	4
57	.77 896	.90 263	.87 633	.12 367	.09 737	.22 104	3
58	.77 913	.90 254	.87 659	.12 341	.09 746	.22 087	2
59	.77 930	.90 244	.87 685	.12 315	.09 756	.22 070	1
60	9.77 946	9.90 235	9.87 711	0.12 289	0.09 765	0.22 054	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

126° (306°) (233°) 53°

37° (217°) (322°) **142°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.77 946	9.90 235	9.87 711	0.12 289	0.09 765	0.22 054	**60**
1	.77 963	.90 225	.87 738	.12 262	.09 775	.22 037	59
2	.77 980	.90 216	.87 764	.12 236	.09 784	.22 020	58
3	.77 997	.90 206	.87 790	.12 210	.09 794	.22 003	57
4	.78 013	.90 197	.87 817	.12 183	.09 803	.21 987	56
5	9.78 030	9.90 187	9.87 843	0.12 157	0.09 813	0.21 970	**55**
6	.78 047	.90 178	.87 869	.12 131	.09 822	.21 953	54
7	.78 063	.90 168	.87 895	.12 105	.09 832	.21 937	53
8	.78 080	.90 159	.87 922	.12 078	.09 841	.21 920	52
9	.78 097	.90 149	.87 948	.12 052	.09 851	.21 903	51
10	9.78 113	9.90 139	9.87 974	0.12 026	0.09 861	0.21 887	**50**
11	.78 130	.90 130	.88 000	.12 000	.09 870	.21 870	49
12	.78 147	.90 120	.88 027	.11 973	.09 880	.21 853	48
13	.78 163	.90 111	.88 053	.11 947	.09 889	.21 837	47
14	.78 180	.90 101	.88 079	.11 921	.09 899	.21 820	46
15	9.78 197	9.90 091	9.88 105	0.11 895	0.09 909	0.21 803	**45**
16	.78 213	.90 082	.88 131	.11 869	.09 918	.21 787	44
17	.78 230	.90 072	.88 158	.11 842	.09 928	.21 770	43
18	.78 246	.90 063	.88 184	.11 816	.09 937	.21 754	42
19	.78 263	.90 053	.88 210	.11 790	.09 947	.21 737	41
20	9.78 280	9.90 043	9.88 236	0.11 764	0.09 957	0.21 720	**40**
21	.78 296	.90 034	.88 262	.11 738	.09 966	.21 704	39
22	.78 313	.90 024	.88 289	.11 711	.09 976	.21 687	38
23	.78 329	.90 014	.88 315	.11 685	.09 986	.21 671	37
24	.78 346	.90 005	.88 341	.11 659	.09 995	.21 654	36
25	9.78 362	9.89 995	9.88 367	0.11 633	0.10 005	0.21 638	**35**
26	.78 379	.89 985	.88 393	.11 607	.10 015	.21 621	34
27	.78 395	.89 976	.88 420	.11 580	.10 024	.21 605	33
28	.78 412	.89 966	.88 446	.11 554	.10 034	.21 588	32
29	.78 428	.89 956	.88 472	.11 528	.10 044	.21 572	31
30	9.78 445	9.89 947	9.88 498	0.11 502	0.10 053	0.21 555	**30**
31	.78 461	.89 937	.88 524	.11 476	.10 063	.21 539	29
32	.78 478	.89 927	.88 550	.11 450	.10 073	.21 522	28
33	.78 494	.89 918	.88 577	.11 423	.10 082	.21 506	27
34	.78 510	.89 908	.88 603	.11 397	.10 092	.21 490	26
35	9.78 527	9.89 898	9.88 629	0.11 371	0.10 102	0.21 473	**25**
36	.78 543	.89 888	.88 655	.11 345	.10 112	.21 457	24
37	.78 560	.89 879	.88 681	.11 319	.10 121	.21 440	23
38	.78 576	.89 869	.88 707	.11 293	.10 131	.21 424	22
39	.78 592	.89 859	.88 733	.11 267	.10 141	.21 408	21
40	9.78 609	9.89 849	9.88 759	0.11 241	0.10 151	0.21 391	**20**
41	.78 625	.89 840	.88 786	.11 214	.10 160	.21 375	19
42	.78 642	.89 830	.88 812	.11 188	.10 170	.21 358	18
43	.78 658	.89 820	.88 838	.11 162	.10 180	.21 342	17
44	.78 674	.89 810	.88 864	.11 136	.10 190	.21 326	16
45	9.78 691	9.89 801	9.88 890	0.11 110	0.10 199	0.21 309	**15**
46	.78 707	.89 791	.88 916	.11 084	.10 209	.21 293	14
47	.78 723	.89 781	.88 942	.11 058	.10 219	.21 277	13
48	.78 739	.89 771	.88 968	.11 032	.10 229	.21 261	12
49	.78 756	.89 761	.88 994	.11 006	.10 239	.21 244	11
50	9.78 772	9.89 752	9.89 020	0.10 980	0.10 248	0.21 228	**10**
51	.78 788	.89 742	.89 046	.10 954	.10 258	.21 212	9
52	.78 805	.89 732	.89 073	.10 927	.10 268	.21 195	8
53	.78 821	.89 722	.89 099	.10 901	.10 278	.21 179	7
54	.78 837	.89 712	.89 125	.10 875	.10 288	.21 163	6
55	9.78 853	9.89 702	9.89 151	0.10 849	0.10 298	0.21 147	**5**
56	.78 869	.89 693	.89 177	.10 823	.10 307	.21 131	4
57	.78 886	.89 683	.89 203	.10 797	.10 317	.21 114	3
58	.78 902	.89 673	.89 229	.10 771	.10 327	.21 098	2
59	.78 918	.89 663	.89 255	.10 745	.10 337	.21 082	1
60	9.78 934	9.89 653	9.89 281	0.10 719	0.10 347	0.21 066	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

127° (307°) (232°) **52°**

38° (218°) (321°) **141°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.78 934	9.89 653	9.89 281	0.10 719	0.10 347	0.21 066	**60**
1	.78 950	.89 643	.89 307	.10 693	.10 357	.21 050	59
2	.78 967	.89 633	.89 333	.10 667	.10 367	.21 033	58
3	.78 983	.89 624	.89 359	.10 641	.10 376	.21 017	57
4	.78 999	.89 614	.89 385	.10 615	.10 386	.21 001	56
5	9.79 015	9.89 604	9.89 411	0.10 589	0.10 396	0.20 985	**55**
6	.79 031	.89 594	.89 437	.10 563	.10 406	.20 969	54
7	.79 047	.89 584	.89 463	.10 537	.10 416	.20 953	53
8	.79 063	.89 574	.89 489	.10 511	.10 426	.20 937	52
9	.79 079	.89 564	.89 515	.10 485	.10 436	.20 921	51
10	9.79 095	9.89 554	9.89 541	0.10 459	0.10 446	0.20 905	**50**
11	.79 111	.89 544	.89 567	.10 433	.10 456	.20 889	49
12	.79 128	.89 534	.89 593	.10 407	.10 466	.20 872	48
13	.79 144	.89 524	.89 619	.10 381	.10 476	.20 856	47
14	.79 160	.89 514	.89 645	.10 355	.10 486	.20 840	46
15	9.79 176	9.89 504	9.89 671	0.10 329	0.10 496	0.20 824	**45**
16	.79 192	.89 495	.89 697	.10 303	.10 505	.20 808	44
17	.79 208	.89 485	.89 723	.10 277	.10 515	.20 792	43
18	.79 224	.89 475	.89 749	.10 251	.10 525	.20 776	42
19	.79 240	.89 465	.89 775	.10 225	.10 535	.20 760	41
20	9.79 256	9.89 455	9.89 801	0.10 199	0.10 545	0.20 744	**40**
21	.79 272	.89 445	.89 827	.10 173	.10 555	.20 728	39
22	.79 288	.89 435	.89 853	.10 147	.10 565	.20 712	38
23	.79 304	.89 425	.89 879	.10 121	.10 575	.20 696	37
24	.79 319	.89 415	.89 905	.10 095	.10 585	.20 681	36
25	9.79 335	9.89 405	9.89 931	0.10 069	0.10 595	0.20 665	**35**
26	.79 351	.89 395	.89 957	.10 043	.10 605	.20 649	34
27	.79 367	.89 385	.89 983	.10 017	.10 615	.20 633	33
28	.79 383	.89 375	.90 009	.09 991	.10 625	.20 617	32
29	.79 399	.89 364	.90 035	.09 965	.10 636	.20 601	31
30	9.79 415	9.89 354	9.90 061	0.09 939	0.10 646	0.20 585	**30**
31	.79 431	.89 344	.90 086	.09 914	.10 656	.20 569	29
32	.79 447	.89 334	.90 112	.09 888	.10 666	.20 553	28
33	.79 463	.89 324	.90 138	.09 862	.10 676	.20 537	27
34	.79 478	.89 314	.90 164	.09 836	.10 686	.20 522	26
35	9.79 494	9.89 304	9.90 190	0.09 810	0.10 696	0.20 506	**25**
36	.79 510	.89 294	.90 216	.09 784	.10 706	.20 490	24
37	.79 526	.89 284	.90 242	.09 758	.10 716	.20 474	23
38	.79 542	.89 274	.90 268	.09 732	.10 726	.20 458	22
39	.79 558	.89 264	.90 294	.09 706	.10 736	.20 442	21
40	9.79 573	9.89 254	9.90 320	0.09 680	0.10 746	0.20 427	**20**
41	.79 589	.89 244	.90 346	.09 654	.10 756	.20 411	19
42	.79 605	.89 233	.90 371	.09 629	.10 767	.20 395	18
43	.79 621	.89 223	.90 397	.09 603	.10 777	.20 379	17
44	.79 636	.89 213	.90 423	.09 577	.10 787	.20 364	16
45	9.79 652	9.89 203	9.90 449	0.09 551	0.10 797	0.20 348	**15**
46	.79 668	.89 193	.90 475	.09 525	.10 807	.20 332	14
47	.79 684	.89 183	.90 501	.09 499	.10 817	.20 316	13
48	.79 699	.89 173	.90 527	.09 473	.10 827	.20 301	12
49	.79 715	.89 162	.90 553	.09 447	.10 838	.20 285	11
50	9.79 731	9.89 152	9.90 578	0.09 422	0.10 848	0.20 269	**10**
51	.79 746	.89 142	.90 604	.09 396	.10 858	.20 254	9
52	.79 762	.89 132	.90 630	.09 370	.10 868	.20 238	8
53	.79 778	.89 122	.90 656	.09 344	.10 878	.20 222	7
54	.79 793	.89 112	.90 682	.09 318	.10 888	.20 207	6
55	9.79 809	9.89 101	9.90 708	0.09 292	0.10 899	0.20 191	**5**
56	.79 825	.89 091	.90 734	.09 266	.10 909	.20 175	4
57	.79 840	.89 081	.90 759	.09 241	.10 919	.20 160	3
58	.79 856	.89 071	.90 785	.09 215	.10 929	.20 144	2
59	.79 872	.89 060	.90 811	.09 189	.10 940	.20 128	1
60	9.79 887	9.89 050	9.90 837	0.09 163	0.10 950	0.20 113	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

128° (308°) (231°) **51°**

39° (219°) (320°) **140°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.79 887	9.89 050	9.90 837	0.09 163	0.10 950	0.20 113	**60**
1	.79 903	.89 040	.90 863	.09 137	.10 960	.20 097	59
2	.79 918	.89 030	.90 889	.09 111	.10 970	.20 082	58
3	.79 934	.89 020	.90 914	.09 086	.10 980	.20 066	57
4	.79 950	.89 009	.90 940	.09 060	.10 991	.20 050	56
5	9.79 965	9.88 999	9.90 966	0.09 034	0.11 001	0.20 035	**55**
6	.79 981	.88 989	.90 992	.09 008	.11 011	.20 019	54
7	.79 996	.88 978	.91 018	.08 982	.11 022	.20 004	53
8	.80 012	.88 968	.91 043	.08 957	.11 032	.19 988	52
9	.80 027	.88 958	.91 069	.08 931	.11 042	.19 973	51
10	9.80 043	9.88 948	9.91 095	0.08 905	0.11 052	0.19 957	**50**
11	.80 058	.88 937	.91 121	.08 879	.11 063	.19 942	49
12	.80 074	.88 927	.91 147	.08 853	.11 073	.19 926	48
13	.80 089	.88 917	.91 172	.08 828	.11 083	.19 911	47
14	.80 105	.88 906	.91 198	.08 802	.11 094	.19 895	46
15	9.80 120	9.88 896	9.91 224	0.08 776	0.11 104	0.19 880	**45**
16	.80 136	.88 886	.91 250	.08 750	.11 114	.19 864	44
17	.80 151	.88 875	.91 276	.08 724	.11 125	.19 849	43
18	.80 166	.88 865	.91 301	.08 699	.11 135	.19 834	42
19	.80 182	.88 855	.91 327	.08 673	.11 145	.19 818	41
20	9.80 197	9.88 844	9.91 353	0.08 647	0.11 156	0.19 803	**40**
21	.80 213	.88 834	.91 379	.08 621	.11 166	.19 787	39
22	.80 228	.88 824	.91 404	.08 596	.11 176	.19 772	38
23	.80 244	.88 813	.91 430	.08 570	.11 187	.19 756	37
24	.80 259	.88 803	.91 456	.08 544	.11 197	.19 741	36
25	9.80 274	9.88 793	9.91 482	0.08 518	0.11 207	0.19 726	**35**
26	.80 290	.88 782	.91 507	.08 493	.11 218	.19 710	34
27	.80 305	.88 772	.91 533	.08 467	.11 228	.19 695	33
28	.80 320	.88 761	.91 559	.08 441	.11 239	.19 680	32
29	.80 336	.88 751	.91 585	.08 415	.11 249	.19 664	31
30	9.80 351	9.88 741	9.91 610	0.08 390	0.11 259	0.19 649	**30**
31	.80 366	.88 730	.91 636	.08 364	.11 270	.19 634	29
32	.80 382	.88 720	.91 662	.08 338	.11 280	.19 618	28
33	.80 397	.88 709	.91 688	.08 312	.11 291	.19 603	27
34	.80 412	.88 699	.91 713	.08 287	.11 301	.19 588	26
35	9.80 428	9.88 688	9.91 739	0.08 261	0.11 312	0.19 572	**25**
36	.80 443	.88 678	.91 765	.08 235	.11 322	.19 557	24
37	.80 458	.88 668	.91 791	.08 209	.11 332	.19 542	23
38	.80 473	.88 657	.91 816	.08 184	.11 343	.19 527	22
39	.80 489	.88 647	.91 842	.08 158	.11 353	.19 511	21
40	9.80 504	9.88 636	9.91 868	0.08 132	0.11 364	0.19 496	**20**
41	.80 519	.88 626	.91 893	.08 107	.11 374	.19 481	19
42	.80 534	.88 615	.91 919	.08 081	.11 385	.19 466	18
43	.80 550	.88 605	.91 945	.08 055	.11 395	.19 450	17
44	.80 565	.88 594	.91 971	.08 029	.11 406	.19 435	16
45	9.80 580	9.88 584	9.91 996	0.08 004	0.11 416	0.19 420	**15**
46	.80 595	.88 573	.92 022	.07 978	.11 427	.19 405	14
47	.80 610	.88 563	.92 048	.07 952	.11 437	.19 390	13
48	.80 625	.88 552	.92 073	.07 927	.11 448	.19 375	12
49	.80 641	.88 542	.92 099	.07 901	.11 458	.19 359	11
50	9.80 656	9.88 531	9.92 125	0.07 875	0.11 469	0.19 344	**10**
51	.80 671	.88 521	.92 150	.07 850	.11 479	.19 329	9
52	.80 686	.88 510	.92 176	.07 824	.11 490	.19 314	8
53	.80 701	.88 499	.92 202	.07 798	.11 501	.19 299	7
54	.80 716	.88 489	.92 227	.07 773	.11 511	.19 284	6
55	9.80 731	9.88 478	9.92 253	0.07 747	0.11 522	0.19 269	**5**
56	.80 746	.88 468	.92 279	.07 721	.11 532	.19 254	4
57	.80 762	.88 457	.92 304	.07 696	.11 543	.19 238	3
58	.80 777	.88 447	.92 330	.07 670	.11 553	.19 223	2
59	.80 792	.88 436	.92 356	.07 644	.11 564	.19 208	1
60	9.80 807	9.88 425	9.92 381	0.07 619	0.11 575	0.19 193	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

129° (309°) (230°) **50°**

40° (220°) (319°) **139°**

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.80 807	9.88 425	9.92 381	0.07 619	0.11 575	0.19 193	**60**
1	.80 822	.88 415	.92 407	.07 593	.11 585	.19 178	59
2	.80 837	.88 404	.92 433	.07 567	.11 596	.19 163	58
3	.80 852	.88 394	.92 458	.07 542	.11 606	.19 148	57
4	.80 867	.88 383	.92 484	.07 516	.11 617	.19 133	56
5	9.80 882	9.88 372	9.92 510	0.07 490	0.11 628	0.19 118	**55**
6	.80 897	.88 362	.92 535	.07 465	.11 638	.19 103	54
7	.80 912	.88 351	.92 561	.07 439	.11 649	.19 088	53
8	.80 927	.88 340	.92 587	.07 413	.11 660	.19 073	52
9	.80 942	.88 330	.92 612	.07 388	.11 670	.19 058	51
10	9.80 957	9.88 319	9.92 638	0.07 362	0.11 681	0.19 043	**50**
11	.80 972	.88 308	.92 663	.07 337	.11 692	.19 028	49
12	.80 987	.88 298	.92 689	.07 311	.11 702	.19 013	48
13	.81 002	.88 287	.92 715	.07 285	.11 713	.18 998	47
14	.81 017	.88 276	.92 740	.07 260	.11 724	.18 983	46
15	9.81 032	9.88 266	9.92 766	0.07 234	0.11 734	0.18 968	**45**
16	.81 047	.88 255	.92 792	.07 208	.11 745	.18 953	44
17	.81 061	.88 244	.92 817	.07 183	.11 756	.18 939	43
18	.81 076	.88 234	.92 843	.07 157	.11 766	.18 924	42
19	.81 091	.88 223	.92 868	.07 132	.11 777	.18 909	41
20	9.81 106	9.88 212	9.92 894	0.07 106	0.11 788	0.18 894	**40**
21	.81 121	.88 201	.92 920	.07 080	.11 799	.18 879	39
22	.81 136	.88 191	.92 945	.07 055	.11 809	.18 864	38
23	.81 151	.88 180	.92 971	.07 029	.11 820	.18 849	37
24	.81 166	.88 169	.92 996	.07 004	.11 831	.18 834	36
25	9.81 180	9.88 158	9.93 022	0.06 978	0.11 842	0.18 820	**35**
26	.81 195	.88 148	.93 048	.06 952	.11 852	.18 805	34
27	.81 210	.88 137	.93 073	.06 927	.11 863	.18 790	33
28	.81 225	.88 126	.93 099	.06 901	.11 874	.18 775	32
29	.81 240	.88 115	.93 124	.06 876	.11 885	.18 760	31
30	9.81 254	9.88 105	9.93 150	0.06 850	0.11 895	0.18 746	**30**
31	.81 269	.88 094	.93 175	.06 825	.11 906	.18 731	29
32	.81 284	.88 083	.93 201	.06 799	.11 917	.18 716	28
33	.81 299	.88 072	.93 227	.06 773	.11 928	.18 701	27
34	.81 314	.88 061	.93 252	.06 748	.11 939	.18 686	26
35	9.81 328	9.88 051	9.93 278	0.06 722	0.11 949	0.18 672	**25**
36	.81 343	.88 040	.93 303	.06 697	.11 960	.18 657	24
37	.81 358	.88 029	.93 329	.06 671	.11 971	.18 642	23
38	.81 372	.88 018	.93 354	.06 646	.11 982	.18 628	22
39	.81 387	.88 007	.93 380	.06 620	.11 993	.18 613	21
40	9.81 402	9.87 996	9.93 406	0.06 594	0.12 004	0.18 598	**20**
41	.81 417	.87 985	.93 431	.06 569	.12 015	.18 583	19
42	.81 431	.87 975	.93 457	.06 543	.12 025	.18 569	18
43	.81 446	.87 964	.92 482	.06 518	.12 036	.18 554	17
44	.81 461	.87 953	.93 508	.06 492	.12 047	.18 539	16
45	9.81 475	9.87 942	9.93 533	0.06 467	0.12 058	0.18 525	**15**
46	.81 490	.87 931	.93 559	.06 441	.12 069	.18 510	14
47	.81 505	.87 920	.93 584	.06 416	.12 080	.18 495	13
48	.81 519	.87 909	.93 610	.06 390	.12 091	.18 481	12
49	.81 534	.87 898	.93 636	.06 364	.12 102	.18 466	11
50	9.81 549	9.87 887	9.93 661	0.06 339	0.12 113	0.18 451	**10**
51	.81 563	.87 877	.93 687	.06 313	.12 123	.18 437	9
52	.81 578	.87 866	.93 712	.06 288	.12 134	.18 422	8
53	.81 592	.87 855	.93 738	.06 262	.12 145	.18 408	7
54	.81 607	.87 844	.93 763	.06 237	.12 156	.18 393	6
55	9.81 622	9.87 833	9.93 789	0.06 211	0.12 167	0.18 378	**5**
56	.81 636	.87 822	.93 814	.06 186	.12 178	.18 364	4
57	.81 651	.87 811	.93 840	.06 160	.12 189	.18 349	3
58	.81 665	.87 800	.93 865	.06 135	.12 200	.18 335	2
59	.81 680	.87 789	.93 891	.06 109	.12 211	.18 320	1
60	9.81 694	9.87 778	9.93 916	0.06 084	0.12 222	.18 306	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

130° (310°) (229°) **49°**

41° (221°) (318°) 138°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.81 694	9.87 778	9.93 916	0.06 084	0.12 222	0.18 306	**60**
1	.81 709	.87 767	.93 942	.06 058	.12 233	.18 291	59
2	.81 723	.87 756	.93 967	.06 033	.12 244	.18 277	58
3	.81 738	.87 745	.93 993	.06 007	.12 255	.18 262	57
4	.81 752	.87 734	.94 018	.05 982	.12 266	.18 248	56
5	9.81 767	9.87 723	9.94 044	0.05 956	0.12 277	0.18 233	**55**
6	.81 781	.87 712	.94 069	.05 931	.12 288	.18 219	54
7	.81 796	.87 701	.94 095	.05 905	.12 299	.18 204	53
8	.81 810	.87 690	.94 120	.05 880	.12 310	.18 190	52
9	.81 825	.87 679	.94 146	.05 854	.12 321	.18 175	51
10	9.81 839	9.87 668	9.94 171	0.05 829	0.12 332	0.18 161	**50**
11	.81 854	.87 657	.94 197	.05 803	.12 343	.18 146	49
12	.81 868	.87 646	.94 222	.05 778	.12 354	.18 132	48
13	.81 882	.87 635	.94 248	.05 752	.12 365	.18 118	47
14	.81 897	.87 624	.94 273	.05 727	.12 376	.18 103	46
15	9.81 911	9.87 613	9.94 299	0.05 701	0.12 387	0.18 089	**45**
16	.81 926	.87 601	.94 324	.05 676	.12 399	.18 074	44
17	.81 940	.87 590	.94 350	.05 650	.12 410	.18 060	43
18	.81 955	.87 579	.94 375	.05 625	.12 421	.18 045	42
19	.81 969	.87 568	.94 401	.05 599	.12 432	.18 031	41
20	9.81 983	9.87 557	9.94 426	0.05 574	0.12 443	0.18 017	**40**
21	.81 998	.87 546	.94 452	.05 548	.12 454	.18 002	39
22	.82 012	.87 535	.94 477	.05 523	.12 465	.17 988	38
23	.82 026	.87 524	.94 503	.05 497	.12 476	.17 974	37
24	.82 041	.87 513	.94 528	.05 472	.12 487	.17 959	36
25	9.82 055	9.87 501	9.94 554	0.05 446	0.12 499	0.17 945	**35**
26	.82 069	.87 490	.94 579	.05 421	.12 510	.17 931	34
27	.82 084	.87 479	.94 604	.05 396	.12 521	.17 916	33
28	.82 098	.87 468	.94 630	.05 370	.12 532	.17 902	32
29	.82 112	.87 457	.94 655	.05 345	.12 543	.17 888	31
30	9.82 126	9.87 446	9.94 681	0.05 319	0.12 554	0.17 874	**30**
31	.82 141	.87 434	.94 706	.05 294	.12 566	.17 859	29
32	.82 155	.87 423	.94 732	.05 268	.12 577	.17 845	28
33	.82 169	.87 412	.94 757	.05 243	.12 588	.17 831	27
34	.82 184	.87 401	.94 783	.05 217	.12 599	.17 816	26
35	9.82 198	9.87 390	9.94 808	0.05 192	0.12 610	0.17 802	**25**
36	.82 212	.87 378	.94 834	.05 166	.12 622	.17 788	24
37	.82 226	.87 367	.94 859	.05 141	.12 633	.17 774	23
38	.82 240	.87 356	.94 884	.05 116	.12 644	.17 760	22
39	.82 255	.87 345	.94 910	.05 090	.12 655	.17 745	21
40	9.82 269	9.87 334	9.94 935	0.05 065	0.12 666	0.17 731	**20**
41	.82 283	.87 322	.94 961	.05 039	.12 678	.17 717	19
42	.82 297	.87 311	.94 986	.05 014	.12 689	.17 703	18
43	.82 311	.87 300	.95 012	.04 988	.12 700	.17 689	17
44	.82 326	.87 288	.95 037	.04 963	.12 712	.17 674	16
45	9.82 340	9.87 277	9.95 062	0.04 938	0.12 723	0.17 660	**15**
46	.82 354	.87 266	.95 088	.04 912	.12 734	.17 646	14
47	.82 368	.87 255	.95 113	.04 887	.12 745	.17 632	13
48	.82 382	.87 243	.95 139	.04 861	.12 757	.17 618	12
49	.82 396	.87 232	.95 164	.04 836	.12 768	.17 604	11
50	9.82 410	9.87 221	9.95 190	0.04 810	0.12 779	0.17 590	**10**
51	.82 424	.87 209	.95 215	.04 785	.12 791	.17 576	9
52	.82 439	.87 198	.95 240	.04 760	.12 802	.17 561	8
53	.82 453	.87 187	.95 266	.04 734	.12 813	.17 547	7
54	.82 467	.87 175	.95 291	.04 709	.12 825	.17 533	6
55	9.82 481	9.87 164	9.95 317	0.04 683	0.12 836	0.17 519	**5**
56	.82 495	.87 153	.95 342	.04 658	.12 847	.17 505	4
57	.82 509	.87 141	.95 368	.04 632	.12 859	.17 491	3
58	.82 523	.87 130	.95 393	.04 607	.12 870	.17 477	2
59	.82 537	.87 119	.95 418	.04 582	.12 881	.17 463	1
60	9.82 551	9.87 107	9.95 444	0.04 556	0.12 893	0.17 449	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

131° (311°) (228°) 48°

42° (222°) (317°) 137°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.82 551	9.87 107	9.95 444	0.04 556	0.12 893	0.17 449	**60**
1	.82 565	.87 096	.95 469	.04 531	.12 904	.17 435	59
2	.82 579	.87 085	.95 495	.04 505	.12 915	.17 421	58
3	.82 593	.87 073	.95 520	.04 480	.12 927	.17 407	57
4	.82 607	.87 062	.95 545	.04 455	.12 938	.17 393	56
5	9.82 621	9.87 050	9.95 571	0.04 429	0.12 950	0.17 379	**55**
6	.82 635	.87 039	.95 596	.04 404	.12 961	.17 365	54
7	.82 649	.87 028	.95 622	.04 378	.12 972	.17 351	53
8	.82 663	.87 016	.95 647	.04 353	.12 984	.17 337	52
9	.82 677	.87 005	.95 672	.04 328	.12 995	.17 323	51
10	9.82 691	9.86 993	9.95 698	0.04 302	0.13 007	0.17 309	**50**
11	.82 705	.86 982	.95 723	.04 277	.13 018	.17 295	49
12	.82 719	.86 970	.95 748	.04 252	.13 030	.17 281	48
13	.82 733	.86 959	.95 774	.04 226	.13 041	.17 267	47
14	.82 747	.86 947	.95 799	.04 201	.13 053	.17 253	46
15	9.82 761	9.86 936	9.95 825	0.04 175	0.13 064	0.17 239	**45**
16	.82 775	.86 924	.95 850	.04 150	.13 076	.17 225	44
17	.82 788	.86 913	.95 875	.04 125	.13 087	.17 212	43
18	.82 802	.86 902	.95 901	.04 099	.13 098	.17 198	42
19	.82 816	.86 890	.95 926	.04 074	.13 110	.17 184	41
20	9.82 830	9.86 879	9.95 952	0.04 048	0.13 121	0.17 170	**40**
21	.82 844	.86 867	.95 977	.04 023	.13 133	.17 156	39
22	.82 858	.86 855	.96 002	.03 998	.13 145	.17 142	38
23	.82 872	.86 844	.96 028	.03 972	.13 156	.17 128	37
24	.82 885	.86 832	.96 053	.03 947	.13 168	.17 115	36
25	9.82 899	9.86 821	9.96 078	0.03 922	0.13 179	0.17 101	**35**
26	.82 913	.86 809	.96 104	.03 896	.13 191	.17 087	34
27	.82 927	.86 798	.96 129	.03 871	.13 202	.17 073	33
28	.82 941	.86 786	.96 155	.03 845	.13 214	.17 059	32
29	.82 955	.86 775	.96 180	.03 820	.13 225	.17 045	31
30	9.82 968	9.86 763	9.96 205	0.03 795	0.13 237	0.17 032	**30**
31	.82 982	.86 752	.96 231	.03 769	.13 248	.17 018	29
32	.82 996	.86 740	.96 256	.03 744	.13 260	.17 004	28
33	.83 010	.86 728	.96 281	.03 719	.13 272	.16 990	27
34	.83 023	.86 717	.96 307	.03 693	.13 283	.16 977	26
35	9.83 037	9.86 705	9.96 332	0.03 668	0.13 295	0.16 963	**25**
36	.83 051	.86 694	.96 357	.03 643	.13 306	.16 949	24
37	.83 065	.86 682	.96 383	.03 617	.13 318	.16 935	23
38	.83 078	.86 670	.96 408	.03 592	.13 330	.16 922	22
39	.83 092	.86 659	.96 433	.03 567	.13 341	.16 908	21
40	9.83 106	9.86 647	9.96 459	0.03 541	0.13 353	0.16 894	**20**
41	.83 120	.86 635	.96 484	.03 516	.13 365	.16 880	19
42	.83 133	.86 624	.96 510	.03 490	.13 376	.16 867	18
43	.83 147	.86 612	.96 535	.03 465	.13 388	.16 853	17
44	.83 161	.86 600	.96 560	.03 440	.13 400	.16 839	16
45	9.83 174	9.86 589	9.96 586	0.03 414	0.13 411	0.16 826	**15**
46	.83 188	.86 577	.96 611	.03 389	.13 423	.16 812	14
47	.83 202	.86 565	.96 636	.03 364	.13 435	.16 798	13
48	.83 215	.86 554	.96 662	.03 338	.13 446	.16 785	12
49	.83 229	.86 542	.96 687	.03 313	.13 458	.16 771	11
50	9.83 242	9.86 530	9.96 712	0.03 288	0.13 470	0.16 758	**10**
51	.83 256	.86 518	.96 738	.03 262	.13 482	.16 744	9
52	.83 270	.86 507	.96 763	.03 237	.13 493	.16 730	8
53	.83 283	.86 495	.96 788	.03 212	.13 505	.16 717	7
54	.83 297	.86 483	.96 814	.03 186	.13 517	.16 703	6
55	9.83 310	9.86 472	9.96 839	0.03 161	0.13 528	0.16 690	**5**
56	.83 324	.86 460	.96 864	.03 136	.13 540	.16 676	4
57	.83 338	.86 448	.96 890	.03 110	.13 552	.16 662	3
58	.83 351	.86 436	.96 915	.03 085	.13 564	.16 649	2
59	.83 365	.86 425	.96 940	.03 060	.13 575	.16 635	1
60	9.83 378	9.86 413	9.96 966	0.03 034	0.13 587	0.16 622	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

132° (312°) (227°) 47°

43° (223°) (316°) 136°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.83 378	9.86 413	9.96 966	0.03 034	0.13 587	0.16 622	**60**
1	.83 392	.86 401	.96 991	.03 009	.13 599	.16 608	59
2	.83 405	.86 389	.97 016	.02 984	.13 611	.16 595	58
3	.83 419	.86 377	.97 042	.02 958	.13 623	.16 581	57
4	.83 432	.86 366	.97 067	.02 933	.13 634	.16 568	56
5	9.83 446	9.86 354	9.97 092	0.02 908	0.13 646	0.16 554	**55**
6	.83 459	.86 342	.97 118	.02 882	.13 658	.16 541	54
7	.83 473	.86 330	.97 143	.02 857	.13 670	.16 527	53
8	.83 486	.86 318	.97 168	.02 832	.13 682	.16 514	52
9	.83 500	.86 306	.97 193	.02 807	.13 694	.16 500	51
10	9.83 513	9.86 295	9.97 219	0.02 781	0.13 705	0.16 487	**50**
11	.83 527	.86 283	.97 244	.02 756	.13 717	.16 473	49
12	.83 540	.86 271	.97 269	.02 731	.13 729	.16 460	48
13	.83 554	.86 259	.97 295	.02 705	.13 741	.16 446	47
14	.83 567	.86 247	.97 320	.02 680	.13 753	.16 433	46
15	9.83 581	9.86 235	9.97 345	0.02 655	0.13 765	0.16 419	**45**
16	.83 594	.86 223	.97 371	.02 629	.13 777	.16 406	44
17	.83 608	.86 211	.97 396	.02 604	.13 789	.16 392	43
18	.83 621	.86 200	.97 421	.02 579	.13 800	.16 379	42
19	.83 634	.86 188	.97 447	.02 553	.13 812	.16 366	41
20	9.83 648	9.86 176	9.97 472	0.02 528	0.13 824	0.16 352	**40**
21	.83 661	.86 164	.97 497	.02 503	.13 836	.16 339	39
22	.83 674	.86 152	.97 523	.02 477	.13 848	.16 326	38
23	.83 688	.86 140	.97 548	.02 452	.13 860	.16 312	37
24	.83 701	.86 128	.97 573	.02 427	.13 872	.16 299	36
25	9.83 715	9.86 116	9.97 598	0.02 402	0.13 884	0.16 285	**35**
26	.83 728	.86 104	.97 624	.02 376	.13 896	.16 272	34
27	.83 741	.86 092	.97 649	.02 351	.13 908	.16 259	33
28	.83 755	.86 080	.97 674	.02 326	.13 920	.16 245	32
29	.83 768	.86 068	.97 700	.02 300	.13 932	.16 232	31
30	9.83 781	9.86 056	9.97 725	0.02 275	0.13 944	0.16 219	**30**
31	.83 795	.86 044	.97 750	.02 250	.13 956	.16 205	29
32	.83 808	.86 032	.97 776	.02 224	.13 968	.16 192	28
33	.83 821	.86 020	.97 801	.02 199	.13 980	.16 179	27
34	.83 834	.86 008	.97 826	.02 174	.13 992	.16 166	26
35	9.83 848	9.85 996	9.97 851	0.02 149	0.14 004	0.16 152	**25**
36	.83 861	.85 984	.97 877	.02 123	.14 016	.16 139	24
37	.83 874	.85 972	.97 902	.02 098	.14 028	.16 126	23
38	.83 887	.85 960	.97 927	.02 073	.14 040	.16 113	22
39	.83 901	.85 948	.97 953	.02 047	.14 052	.16 099	21
40	9.83 914	9.85 936	9.97 978	0.02 022	0.14 064	0.16 086	**20**
41	.83 927	.85 924	.98 003	.01 997	.14 076	.16 073	19
42	.83 940	.85 912	.98 029	.01 971	.14 088	.16 060	18
43	.83 954	.85 900	.98 054	.01 946	.14 100	.16 046	17
44	.83 967	.85 888	.98 079	.01 921	.14 112	.16 033	16
45	9.83 980	9.85 876	9.98 104	0.01 896	0.14 124	0.16 020	**15**
46	.83 993	.85 864	.98 130	.01 870	.14 136	.16 007	14
47	.84 006	.85 851	.98 155	.01 845	.14 149	.15 994	13
48	.84 020	.85 839	.98 180	.01 820	.14 161	.15 980	12
49	.84 033	.85 827	.98 206	.01 794	.14 173	.15 967	11
50	9.84 046	9.85 815	9.98 231	0.01 769	0.14 185	0.15 954	**10**
51	.84 059	.85 803	.98 256	.01 744	.14 197	.15 941	9
52	.84 072	.85 791	.98 281	.01 719	.14 209	.15 928	8
53	.84 085	.85 779	.98 307	.01 693	.14 221	.15 915	7
54	.84 098	.85 766	.98 332	.01 668	.14 234	.15 902	6
55	9.84 112	9.85 754	9.98 357	0.01 643	0.14 246	0.15 888	**5**
56	.84 125	.85 742	.98 383	.01 617	.14 258	.15 875	4
57	.84 138	.85 730	.98 408	.01 592	.14 270	.15 862	3
58	.84 151	.85 718	.98 433	.01 567	.14 282	.15 849	2
59	.84 164	.85 706	.98 458	.01 542	.14 294	.15 836	1
60	9.84 177	9.85 693	9.98 484	0.01 516	0.14 307	0.15 823	**0**
	Cos	**Sin**	**Cot**	**Tan**	**Csc**	**Sec**	′

133° (313°) (226°) 46°

44° (224°) (315°) 135°

′	Sin	Cos	Tan	Cot	Sec	Csc	
0	9.84 177	9.85 693	9.98 484	0.01 516	0.14 307	0.15 823	**60**
1	.84 190	.85 681	.98 509	.01 491	.14 319	.15 810	59
2	.84 203	.85 669	.98 534	.01 466	.14 331	.15 797	58
3	.84 216	.85 657	.98 560	.01 440	.14 343	.15 784	57
4	.84 229	.85 645	.98 585	.01 415	.14 355	.15 771	56
5	9.84 242	9.85 632	9.98 610	0.01 390	0.14 368	0.15 758	**55**
6	.84 255	.85 620	.98 635	.01 365	.14 380	.15 745	54
7	.84 269	.85 608	.98 661	.01 339	.14 392	.15 731	53
8	.84 282	.85 596	.98 686	.01 314	.14 404	.15 718	52
9	.84 295	.85 583	.98 711	.01 289	.14 417	.15 705	51
10	9.84 308	9.85 571	9.98 737	0.01 263	0.14 429	0.15 692	**50**
11	.84 321	.85 559	.98 762	.01 238	.14 441	.15 679	49
12	.84 334	.85 547	.98 787	.01 213	.14 453	.15 666	48
13	.84 347	.85 534	.98 812	.01 188	.14 466	.15 653	47
14	.84 360	.85 522	.98 838	.01 162	.14 478	.15 640	46
15	9.84 373	9.85 510	9.98 863	0.01 137	0.14 490	0.15 627	**45**
16	.84 385	.85 497	.98 888	.01 112	.14 503	.15 615	44
17	.84 398	.85 485	.98 913	.01 087	.14 515	.15 602	43
18	.84 411	.85 473	.98 939	.01 061	.14 527	.15 589	42
19	.84 424	.85 460	.98 964	.01 036	.14 540	.15 576	41
20	9.84 437	9.85 448	9.98 989	0.01 011	0.14 552	0.15 563	**40**
21	.84 450	.85 436	.99 015	.00 985	.14 564	.15 550	39
22	.84 463	.85 423	.99 040	.00 960	.14 577	.15 537	38
23	.84 476	.85 411	.99 065	.00 935	.14 589	.15 524	37
24	.84 489	.85 399	.99 090	.00 910	.14 601	.15 511	36
25	9.84 502	9.85 386	9.99 116	0.00 884	0.14 614	0.15 498	**35**
26	.84 515	.85 374	.99 141	.00 859	.14 626	.15 485	34
27	.84 528	.85 361	.99 166	.00 834	.14 639	.15 472	33
28	.84 540	.85 349	.99 191	.00 809	.14 651	.15 460	32
29	.84 553	.85 337	.99 217	.00 783	.14 663	.15 447	31
30	9.84 566	9.85 324	9.99 242	0.00 758	0.14 676	0.15 434	**30**
31	.84 579	.85 312	.99 267	.00 733	.14 688	.15 421	29
32	.84 592	.85 299	.99 293	.00 707	.14 701	.15 408	28
33	.84 605	.85 287	.99 318	.00 682	.14 713	.15 395	27
34	.84 618	.85 274	.99 343	.00 657	.14 726	.15 382	26
35	9.84 630	9.85 262	9.99 368	0.00 632	0.14 738	0.15 370	**25**
36	.84 643	.85 250	.99 394	.00 606	.14 750	.15 357	24
37	.84 656	.85 237	.99 419	.00 581	.14 763	.15 344	23
38	.84 669	.85 225	.99 444	.00 556	.14 775	.15 331	22
39	.84 682	.85 212	.99 469	.00 531	.14 788	.15 318	21
40	9.84 694	9.85 200	9.99 495	0.00 505	0.14 800	0.15 306	**20**
41	.84 707	.85 187	.99 520	.00 480	.14 813	.15 293	19
42	.84 720	.85 175	.99 545	.00 455	.14 825	.15 280	18
43	.84 733	.85 162	.99 570	.00 430	.14 838	.15 267	17
44	.84 745	.85 150	.99 596	.00 404	.14 850	.15 255	16
45	9.84 758	9.85 137	9.99 621	0.00 379	0.14 863	0.15 242	**15**
46	.84 771	.85 125	.99 646	.00 354	.14 875	.15 229	14
47	.84 784	.85 112	.99 672	.00 328	.14 888	.15 216	13
48	.84 796	.85 100	.99 697	.00 303	.14 900	.15 204	12
49	.84 809	.85 087	.99 722	.00 278	.14 913	.15 191	11
50	9.84 822	9.85 074	9.99 747	0.00 253	0.14 926	0.15 178	**10**
51	.84 835	.85 062	.99 773	.00 227	.14 938	.15 165	9
52	.84 847	.85 049	.99 798	.00 202	.14 951	.15 153	8
53	.84 860	.85 037	.99 823	.00 177	.14 963	.15 140	7
54	.84 873	.85 024	.99 848	.00 152	.14 976	.15 127	6
55	9.84 885	9.85 012	9.99 874	0.00 126	0.14 988	0.15 115	**5**
56	.84 898	.84 999	.99 899	.00 101	.15 001	.15 102	4
57	.84 911	.84 986	.99 924	.00 076	.15 014	.15 089	3
58	.84 923	.84 974	.99 949	.00 051	.15 026	.15 077	2
59	.84 936	.84 961	.99 975	.00 025	.15 039	.15 064	1
60	9.84 949	9.84 949	0.00 000	0.00 000	0.15 051	0.15 051	**0**
	Cos	Sin	Cot	Tan	Csc	Sec	′

134° (314°) (225°) 45°

′	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	′
0	0.0	59.6	119.2	178.9	238.6	298.3	358.2	418.2	478.3	538.6	**0**
1	1.0	60.6	20.2	79.9	39.6	99.3	59.2	19.2	79.3	39.6	1
2	2.0	61.6	21.2	80.8	40.6	300.3	60.2	20.2	80.3	40.6	2
3	3.0	62.6	22.2	81.8	41.6	01.3	61.2	21.2	81.3	41.6	3
4	4.0	63.6	23.2	82.8	42.5	02.3	62.2	22.2	82.3	42.6	4
5	5.0	64.6	124.2	183.8	243.5	303.3	363.2	423.2	483.3	543.6	**5**
6	6.0	65.6	25.2	84.8	44.5	04.3	64.2	24.2	84.3	44.6	6
7	7.0	66.5	26.2	85.8	45.5	05.3	65.2	25.2	85.3	45.6	7
8	7.9	67.5	27.2	86.8	46.5	06.3	66.2	26.2	86.3	46.6	8
9	8.9	68.5	28.2	87.8	47.5	07.3	67.2	27.2	87.3	47.6	9
10	9.9	69.5	129.1	188.8	248.5	308.3	368.2	428.2	488.3	548.6	**10**
11	10.9	70.5	30.1	89.8	49.5	09.3	69.2	29.2	89.3	49.6	11
12	11.9	71.5	31.1	90.8	50.5	10.3	70.2	30.2	90.4	50.6	12
13	12.9	72.5	32.1	91.8	51.5	11.3	71.2	31.2	91.4	51.7	13
14	13.9	73.5	33.1	92.8	52.5	12.3	72.2	32.2	92.4	52.7	14
15	14.9	74.5	134.1	193.8	253.5	313.3	373.2	433.2	493.4	553.7	**15**
16	15.9	75.5	35.1	94.8	54.5	14.3	74.2	34.2	94.4	54.7	16
17	16.9	76.5	36.1	95.8	55.5	15.3	75.2	35.2	95.4	55.7	17
18	17.9	77.5	37.1	96.8	56.5	16.3	76.2	36.2	96.4	56.7	18
19	18.9	78.5	38.1	97.8	57.5	17.3	77.2	37.2	97.4	57.7	19
20	19.9	79.5	139.1	198.8	258.5	318.3	378.2	438.2	498.4	558.7	**20**
21	20.9	80.5	40.1	99.7	59.5	19.3	79.2	39.2	99.4	59.7	21
22	21.9	81.5	41.1	200.7	60.5	20.3	80.2	40.2	500.4	60.7	22
23	22.8	82.4	42.1	01.7	61.5	21.3	81.2	41.2	01.4	61.7	23
24	23.8	83.4	43.1	02.7	62.5	22.3	82.2	42.2	02.4	62.7	24
25	24.8	84.4	144.1	203.7	263.5	323.3	383.2	443.2	503.4	563.7	**25**
26	25.8	85.4	45.1	04.7	64.5	24.3	84.2	44.2	04.4	64.7	26
27	26.8	86.4	46.0	05.7	65.5	25.3	85.2	45.2	05.4	65.7	27
28	27.8	87.4	47.0	06.7	66.5	26.3	86.2	46.2	06.4	66.8	28
29	28.8	88.4	48.0	07.7	67.4	27.3	87.2	47.2	07.4	67.8	29
30	29.8	89.4	149.0	208.7	268.4	328.3	388.2	448.2	508.4	568.8	**30**
31	30.8	90.4	50.0	09.7	69.4	29.3	89.2	49.2	09.4	69.8	31
32	31.8	91.4	51.0	10.7	70.4	30.3	90.2	50.2	10.4	70.8	32
33	32.8	92.4	52.0	11.7	71.4	31.3	91.2	51.2	11.4	71.8	33
34	33.8	93.4	53.0	12.7	72.4	32.3	92.2	52.2	12.4	72.8	34
35	34.8	94.4	154.0	213.7	273.4	333.3	393.2	453.2	513.4	573.8	**35**
36	35.8	95.4	55.0	14.7	74.4	34.3	94.2	54.3	14.5	74.8	36
37	36.7	96.4	56.0	15.7	75.4	35.3	95.2	55.3	15.5	75.8	37
38	37.7	97.3	57.0	16.7	76.4	36.2	96.2	56.3	16.5	76.8	38
39	38.7	98.3	58.0	17.7	77.4	37.2	97.2	57.3	17.5	77.8	39
40	39.7	99.3	159.0	218.7	278.4	338.2	398.2	458.3	518.5	578.8	**40**
41	40.7	100.3	60.0	19.7	79.4	39.2	99.2	59.3	19.5	79.9	41
42	41.7	01.3	61.0	20.6	80.4	40.2	400.2	60.3	20.5	80.9	42
43	42.7	02.3	62.0	21.6	81.4	41.2	01.2	61.3	21.5	81.9	43
44	43.7	03.3	63.0	22.6	82.4	42.2	02.2	62.3	22.5	82.9	44
45	44.7	104.3	164.0	223.6	283.4	343.2	403.2	463.3	523.5	583.9	**45**
46	45.7	05.3	65.0	24.6	84.4	44.2	04.2	64.3	24.5	84.9	46
47	46.7	06.3	66.0	25.6	85.4	45.2	05.2	65.3	25.5	85.9	47
48	47.7	07.3	67.0	26.6	86.4	46.2	06.2	66.3	26.5	86.9	48
49	48.7	08.3	68.0	27.6	87.4	47.2	07.2	67.3	27.5	87.9	49
50	49.7	109.3	168.9	228.6	288.4	348.2	408.2	468.3	528.5	588.9	**50**
51	50.7	10.3	69.9	29.6	89.4	49.2	09.2	69.3	29.5	89.9	51
52	51.6	11.3	70.9	30.6	90.4	50.2	10.2	70.3	30.5	90.9	52
53	52.6	12.3	71.9	31.6	91.4	51.2	11.2	71.3	31.5	91.9	53
54	53.6	13.2	72.9	32.6	92.4	52.2	12.2	72.3	32.5	93.0	54
55	54.6	114.2	173.9	233.6	293.4	353.2	413.2	473.3	533.5	594.0	**55**
56	55.6	15.2	74.9	34.6	94.4	54.2	14.2	74.3	34.6	95.0	56
57	56.6	16.2	75.9	35.6	95.4	55.2	15.2	75.3	35.6	96.0	57
58	57.6	17.2	76.9	36.6	96.3	56.2	16.2	76.3	36.6	97.0	58
59	58.6	18.2	77.9	37.6	97.3	57.2	17.2	77.3	37.6	98.0	59
60	59.6	119.2	178.9	238.6	298.3	358.2	418.2	478.3	538.6	599.0	**60**
′	**0°**	**1°**	**2°**	**3°**	**4°**	**5°**	**6°**	**7°**	**8°**	**9°**	**′**

′	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	′
0	599.0	659.6	720.5	781.5	842.8	904.4	966.3	1028.5	1091.0	1153.9	**0**
1	600.0	60.6	21.5	82.5	43.9	05.4	67.3	29.5	92.0	54.9	1
2	01.0	61.7	22.5	83.6	44.9	06.5	68.3	30.5	93.1	56.0	2
3	02.0	62.7	23.5	84.6	45.9	07.5	69.4	31.6	94.1	57.0	3
4	03.0	63.7	24.5	85.6	46.9	08.5	70.4	32.6	95.2	58.1	4
5	604.1	664.7	725.5	786.6	847.9	909.6	971.4	1033.7	1096.2	1159.1	**5**
6	05.1	65.7	26.6	87.6	49.0	10.6	72.5	34.7	97.3	60.2	6
7	06.1	66.7	27.6	88.7	50.0	11.6	73.5	35.7	98.3	61.2	7
8	07.1	67.7	28.6	89.7	51.0	12.6	74.6	36.8	99.4	62.3	8
9	08.1	68.7	29.6	90.7	52.0	13.7	75.6	37.8	1100.4	63.3	9
10	609.1	669.8	730.6	791.7	853.1	914.7	976.6	1038.9	1101.4	1164.4	**10**
11	10.1	70.8	31.6	92.7	54.1	15.7	77.7	39.9	02.5	65.4	11
12	11.1	71.8	32.7	93.8	55.1	16.8	78.7	40.9	03.5	66.5	12
13	12.1	72.8	33.7	94.8	56.1	17.8	79.7	42.0	04.6	67.5	13
14	13.1	73.8	34.7	95.8	57.2	18.8	80.8	43.0	05.6	68.6	14
15	614.1	674.8	735.7	796.8	858.2	919.8	981.8	1044.1	1106.7	1169.7	**15**
16	15.2	75.8	36.7	97.8	59.2	20.9	82.8	45.1	07.7	70.7	16
17	16.2	76.8	37.7	98.9	60.2	21.9	83.9	46.1	08.8	71.8	17
18	17.2	77.9	38.8	99.9	61.3	22.9	84.9	47.2	09.8	72.8	18
19	18.2	78.9	39.8	800.9	62.3	24.0	85.9	48.2	10.9	73.9	19
20	619.2	679.9	740.8	801.9	863.3	925.0	987.0	1049.3	1111.9	1174.9	**20**
21	20.2	80.9	41.8	02.9	64.3	26.0	88.0	50.3	13.0	76.0	21
22	21.2	81.9	42.8	04.0	65.4	27.1	89.0	51.3	14.0	77.0	22
23	22.2	82.9	43.8	05.0	66.4	28.1	90.1	52.4	15.0	78.1	23
24	23.2	83.9	44.9	06.0	67.4	29.1	91.1	53.4	16.1	79.1	24
25	624.2	684.9	745.9	807.0	868.5	930.1	992.1	1054.5	1117.1	1180.2	**25**
26	25.3	86.0	46.9	08.1	69.5	31.2	93.2	55.5	18.2	81.2	26
27	26.3	87.0	47.9	09.1	70.5	32.2	94.2	56.6	19.2	82.3	27
28	27.3	88.0	48.9	10.1	71.5	33.2	95.3	57.6	20.3	83.3	28
29	28.3	89.0	49.9	11.1	72.6	34.3	96.3	58.6	21.3	84.4	29
30	629.3	690.0	751.0	812.1	873.6	935.3	997.3	1059.7	1122.4	1185.5	**30**
31	30.3	91.0	52.0	13.2	74.6	36.3	98.4	60.7	23.4	86.5	31
32	31.3	92.0	53.0	14.2	75.6	37.4	99.4	61.8	24.5	87.6	32
33	32.3	93.1	54.0	15.2	76.7	38.4	1000.4	62.8	25.5	88.6	33
34	33.3	94.1	55.0	16.2	77.7	39.4	01.5	63.9	26.6	89.7	34
35	634.3	695.1	756.0	817.3	878.7	940.5	1002.5	1064.9	1127.6	1190.7	**35**
36	35.4	96.1	57.1	18.3	79.7	41.5	03.6	65.9	28.7	91.8	36
37	36.4	97.1	58.1	19.3	80.8	42.5	04.6	67.0	29.7	92.8	37
38	37.4	98.1	59.1	20.3	81.8	43.6	05.6	68.0	30.8	93.9	38
39	38.4	99.1	60.1	21.3	82.8	44.6	06.7	69.1	31.8	95.0	39
40	639.4	700.2	761.1	822.4	883.8	945.6	1007.7	1070.1	1132.9	1196.0	**40**
41	40.4	01.2	62.2	23.4	84.9	46.7	08.7	71.2	33.9	97.1	41
42	41.4	02.2	63.2	24.4	85.9	47.7	09.8	72.2	35.0	98.1	42
43	42.4	03.2	64.2	25.4	86.9	48.7	10.8	73.2	36.0	99.2	43
44	43.4	04.2	65.2	26.5	88.0	49.7	11.8	74.3	37.1	1200.2	44
45	644.5	705.2	766.2	827.5	889.0	950.8	1012.9	1075.3	1138.1	1201.3	**45**
46	45.5	06.2	67.3	28.5	90.0	51.8	13.9	76.4	39.2	02.3	46
47	46.5	07.3	68.3	29.5	91.0	52.8	15.0	77.4	40.2	03.4	47
48	47.5	08.3	69.3	30.5	92.1	53.9	16.0	78.5	41.3	04.5	48
49	48.5	09.3	70.3	31.6	93.1	54.9	17.0	79.5	42.3	05.5	49
50	649.5	710.3	771.3	832.6	894.1	955.9	1018.1	1080.5	1143.4	1206.6	**50**
51	50.5	11.3	72.3	33.6	95.2	57.0	19.1	81.6	44.4	07.6	51
52	51.5	12.3	73.4	34.6	96.2	58.0	20.2	82.6	45.5	08.7	52
53	52.5	13.4	74.4	35.7	97.2	59.0	21.2	83.7	46.5	09.7	53
54	53.6	14.4	75.4	36.7	98.2	60.1	22.2	84.7	47.6	10.8	54
55	654.6	715.4	776.4	837.7	899.3	961.1	1023.3	1085.8	1148.6	1211.8	**55**
56	55.6	16.4	77.4	38.7	900.3	62.1	24.3	86.8	49.7	12.9	56
57	56.6	17.4	78.5	39.8	01.3	63.2	25.3	87.9	50.7	14.0	57
58	57.6	18.4	79.5	40.8	02.3	64.2	26.4	88.9	51.8	15.0	58
59	58.6	19.4	80.5	41.8	03.4	65.2	27.4	89.9	52.8	16.1	59
60	659.6	720.5	781.5	842.8	904.4	966.3	1028.5	1091.0	1153.9	1217.1	**60**
′	**10°**	**11°**	**12°**	**13°**	**14°**	**15°**	**16°**	**17°**	**18°**	**19°**	′

′	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	′
0	1217.1	1280.8	1344.9	1409.5	1474.5	1540.1	1606.2	1672.9	1740.2	1808.1	**0**
1	18.2	81.9	46.0	10.6	75.6	41.2	07.3	74.0	41.3	09.2	1
2	19.3	82.9	47.1	11.6	76.7	42.3	08.4	75.1	42.4	10.4	2
3	20.3	84.0	48.1	12.7	77.8	43.4	09.5	76.2	43.6	11.5	3
4	21.4	85.1	49.2	13.8	78.9	44.5	10.6	77.4	44.7	12.6	4
5	1222.4	1286.1	1350.3	1414.9	1480.0	1545.6	1611.7	1678.5	1745.8	1813.8	**5**
6	23.5	87.2	51.4	16.0	81.1	46.7	12.9	79.6	46.9	14.9	6
7	24.5	88.3	52.4	17.1	82.2	47.8	14.0	80.7	48.1	16.1	7
8	25.6	89.3	53.5	18.1	83.3	48.9	15.1	81.8	49.2	17.2	8
9	26.7	90.4	54.6	19.2	84.3	50.0	16.2	82.9	50.3	18.3	9
10	1227.7	1291.5	1355.7	1420.3	1485.4	1551.1	1617.3	1684.1	1751.5	1819.5	**10**
11	28.8	92.5	56.7	21.4	86.5	52.2	18.4	85.2	52.6	20.6	11
12	29.8	93.6	57.8	22.5	87.6	53.3	19.5	86.3	53.7	21.8	12
13	30.9	94.7	58.9	23.5	88.7	54.4	20.6	87.4	54.8	22.9	13
14	32.0	95.7	59.9	24.6	89.8	55.5	21.7	88.5	56.0	24.0	14
15	1233.0	1296.8	1361.0	1425.7	1490.9	1556.6	1622.8	1689.7	1757.1	1825.2	**15**
16	34.1	97.9	62.1	26.8	92.0	57.7	23.9	90.8	58.2	26.3	16
17	35.1	98.9	63.2	27.9	93.1	58.8	25.0	91.9	59.4	27.5	17
18	36.2	1300.0	64.2	29.0	94.2	59.9	26.2	93.0	60.5	28.6	18
19	37.3	01.1	65.3	30.0	95.2	61.0	27.3	94.1	61.6	29.7	19
20	1238.3	1302.1	1366.4	1431.1	1496.3	1562.1	1628.4	1695.3	1762.7	1830.9	**20**
21	39.4	03.2	67.5	32.2	97.4	63.2	29.5	96.4	63.9	32.0	21
22	40.4	04.3	68.5	33.3	98.5	64.3	30.6	97.5	65.0	33.2	22
23	41.5	05.3	69.6	34.4	99.6	65.4	31.7	98.6	66.1	34.3	23
24	42.6	06.4	70.7	35.4	1500.7	66.5	32.8	99.7	67.3	35.4	24
25	1243.6	1307.5	1371.8	1436.5	1501.8	1567.6	1633.9	1700.9	1768.4	1836.6	**25**
26	44.7	08.5	72.8	37.6	02.9	68.7	35.0	02.0	69.5	37.7	26
27	45.7	09.6	73.9	38.7	04.0	69.8	36.1	03.1	70.7	38.9	27
28	46.8	10.7	75.0	39.8	05.1	70.9	37.3	04.2	71.8	40.0	28
29	47.9	11.7	76.1	40.9	06.2	72.0	38.4	05.3	72.9	41.2	29
30	1248.9	1312.8	1377.1	1442.0	1507.3	1573.1	1639.5	1706.5	1774.1	1842.3	**30**
31	50.0	13.9	78.2	43.0	08.4	74.2	40.6	07.6	75.2	43.4	31
32	51.0	14.9	79.3	44.1	09.4	75.3	41.7	08.7	76.3	44.6	32
33	52.1	16.0	80.4	45.2	10.5	76.4	42.8	09.8	77.4	45.7	33
34	53.2	17.1	81.5	46.3	11.6	77.5	43.9	10.9	78.6	46.9	34
35	1254.2	1318.2	1382.5	1447.4	1512.7	1578.6	1645.0	1712.1	1779.7	1848.0	**35**
36	55.3	19.2	83.6	48.5	13.8	79.7	46.2	13.2	80.8	49.2	36
37	56.4	20.3	84.7	49.5	14.9	80.8	47.3	14.3	82.0	50.3	37
38	57.4	21.4	85.8	50.6	16.0	81.9	48.4	15.4	83.1	51.4	38
39	58.5	22.4	86.8	51.7	17.1	83.0	49.5	16.6	84.2	52.6	39
40	1259.5	1323.5	1387.9	1452.8	1518.2	1584.1	1650.6	1717.7	1785.4	1853.7	**40**
41	60.6	24.6	89.0	53.9	19.3	85.2	51.7	18.8	86.5	54.9	41
42	61.7	25.6	90.1	55.0	20.4	86.3	52.8	19.9	87.6	56.0	42
43	62.7	26.7	91.1	56.1	21.5	87.4	53.9	21.1	88.8	57.2	43
44	63.8	27.8	92.2	57.1	22.6	88.5	55.1	22.2	89.9	58.3	44
45	1264.9	1328.9	1393.3	1458.2	1523.7	1589.6	1656.2	1723.3	1791.1	1859.5	**45**
46	65.9	29.9	94.4	59.3	24.8	90.7	57.3	24.4	92.2	60.6	46
47	67.0	31.0	95.5	60.4	25.9	91.8	58.4	25.5	93.3	61.8	47
48	68.0	32.1	96.5	61.5	27.0	92.9	59.5	26.7	94.5	62.9	48
49	69.1	33.1	97.6	62.6	28.0	94.1	60.6	27.8	95.6	64.0	49
50	1270.2	1334.2	1398.7	1463.7	1529.1	1595.2	1661.7	1728.9	1796.7	1865.2	**50**
51	71.2	35.3	99.8	64.8	30.2	96.3	62.9	30.0	97.9	66.3	51
52	72.3	36.3	1400.9	65.8	31.3	97.4	64.0	31.2	99.0	67.5	52
53	73.4	37.4	01.9	66.9	32.4	98.5	65.1	32.3	1800.1	68.6	53
54	74.4	38.5	03.0	68.0	33.5	99.6	66.2	33.4	01.3	69.8	54
55	1275.5	1339.6	1404.1	1469.1	1534.6	1600.7	1667.3	1734.5	1802.4	1870.9	**55**
56	76.6	40.6	05.2	70.2	35.7	01.8	68.4	35.7	03.5	72.1	56
57	77.6	41.7	06.2	71.3	36.8	02.9	69.5	36.8	04.7	73.2	57
58	78.7	42.8	07.3	72.4	37.9	04.0	70.7	37.9	05.8	74.4	58
59	79.7	43.8	08.4	73.5	39.0	05.1	71.8	39.1	07.0	75.5	59
60	1280.8	1344.9	1409.5	1474.5	1540.1	1606.2	1672.9	1740.2	1808.1	1876.7	**60**
′	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	′

Table 5. Meridional Parts

′	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	′
0	1876.7	1946.0	2016.0	2086.8	2158.4	2230.9	2304.2	2378.5	2453.8	2530.2	**0**
1	77.8	47.1	17.2	88.0	59.6	32.1	05.5	79.8	55.1	31.5	1
2	79.0	48.3	18.3	89.2	60.8	33.3	06.7	81.0	56.4	32.8	2
3	80.1	49.4	19.5	90.3	62.0	34.5	07.9	82.3	57.6	34.0	3
4	81.3	50.6	20.7	91.5	63.2	35.7	09.2	83.5	58.9	35.3	4
5	1882.4	1951.8	2021.9	2092.7	2164.4	2236.9	2310.4	2384.8	2460.2	2536.6	**5**
6	83.6	52.9	23.0	93.9	65.6	38.2	11.6	86.0	61.4	37.9	6
7	84.7	54.1	24.2	95.1	66.8	39.4	12.9	87.3	62.7	39.2	7
8	85.9	55.3	25.4	96.3	68.0	40.6	14.1	88.5	64.0	40.5	8
9	87.0	56.4	26.6	97.5	69.2	41.8	15.3	89.8	65.2	41.7	9
10	1888.2	1957.6	2027.7	2098.7	2170.4	2243.0	2316.5	2391.0	2466.5	2543.0	**10**
11	89.3	58.7	28.9	99.8	71.6	44.2	17.8	92.3	67.8	44.3	11
12	90.5	59.9	30.1	2101.0	72.8	45.5	19.0	93.5	69.0	45.6	12
13	91.6	61.1	31.3	02.2	74.0	46.7	20.3	94.8	70.3	46.9	13
14	92.8	62.2	32.4	03.4	75.2	47.9	21.5	96.0	71.6	48.2	14
15	1893.9	1963.4	2033.6	2104.6	2176.4	2249.1	2322.7	2397.3	2472.8	2549.5	**15**
16	95.1	64.6	34.8	05.8	77.6	50.3	24.0	98.5	74.1	50.7	16
17	96.2	65.7	36.0	07.0	78.8	51.6	25.2	99.8	75.4	52.0	17
18	97.4	66.9	37.1	08.2	80.0	52.8	26.4	2401.0	76.6	53.3	18
19	98.5	68.1	38.3	09.4	81.2	54.0	27.7	02.3	77.9	54.6	19
20	1899.7	1969.2	2039.5	2110.6	2182.5	2255.2	2328.9	2403.5	2479.2	2555.9	**20**
21	1900.8	70.4	40.7	11.8	83.7	56.4	30.1	04.8	80.4	57.2	21
22	02.0	71.5	41.8	12.9	84.9	57.7	31.4	06.0	81.7	58.5	22
23	03.1	72.7	43.0	14.1	86.1	58.9	32.6	07.3	83.0	59.8	23
24	04.3	73.9	44.2	15.3	87.3	60.1	33.8	08.5	84.3	61.0	24
25	1905.5	1975.0	2045.4	2116.5	2188.5	2261.3	2335.1	2409.8	2485.5	2562.3	**25**
26	06.6	76.2	46.6	17.7	89.7	62.5	36.3	11.1	86.8	63.6	26
27	07.8	77.4	47.7	18.9	90.9	63.8	37.6	12.3	88.1	64.9	27
28	08.9	78.5	48.9	20.1	92.1	65.0	38.8	13.6	89.3	66.2	28
29	10.1	79.7	50.1	21.3	93.3	66.2	40.0	14.8	90.6	67.5	29
30	1911.2	1980.9	2051.3	2122.5	2194.5	2267.4	2341.3	2416.1	2491.9	2568.8	**30**
31	12.4	82.0	52.5	23.7	95.7	68.7	42.5	17.3	93.2	70.1	31
32	13.5	83.2	53.6	24.9	96.9	69.9	43.7	18.6	94.4	71.4	32
33	14.7	84.4	54.8	26.1	98.1	71.1	45.0	19.8	95.7	72.7	33
34	15.8	85.5	56.0	27.3	99.4	72.3	46.2	21.1	97.0	73.9	34
35	1917.0	1986.7	2057.2	2128.5	2200.6	2273.5	2347.5	2422.3	2498.3	2575.2	**35**
36	18.2	87.9	58.4	29.6	01.8	74.8	48.7	23.6	99.5	76.5	36
37	19.3	89.1	59.5	30.8	03.0	76.0	49.9	24.9	2500.8	77.8	37
38	20.5	90.2	60.7	32.0	04.2	77.2	51.2	26.1	02.1	79.1	38
39	21.6	91.4	61.9	33.2	05.4	78.4	52.4	27.4	03.4	80.4	39
40	1922.8	1992.6	2063.1	2134.4	2206.6	2279.7	2353.7	2428.6	2504.6	2581.7	**40**
41	23.9	93.7	64.3	35.6	07.8	80.9	54.9	29.9	05.9	83.0	41
42	25.1	94.9	65.5	36.8	09.0	82.1	56.1	31.2	07.2	84.3	42
43	26.3	96.1	66.6	38.0	10.2	83.3	57.4	32.4	08.5	85.6	43
44	27.4	97.2	67.8	39.2	11.5	84.6	58.6	33.7	09.7	86.9	44
45	1928.6	1998.4	2069.0	2140.4	2212.7	2285.8	2359.9	2434.9	2511.0	2588.2	**45**
46	29.7	99.6	70.2	41.6	13.9	87.0	61.1	36.2	12.3	89.5	46
47	30.9	2000.7	71.4	42.8	15.1	88.3	62.4	37.4	13.6	90.8	47
48	32.0	01.9	72.6	44.0	16.3	89.5	63.6	38.7	14.8	92.1	48
49	33.2	03.1	73.7	45.2	17.5	90.7	64.8	40.0	16.1	93.4	49
50	1934.4	2004.3	2074.9	2146.4	2218.7	2291.9	2366.1	2441.2	2517.4	2594.7	**50**
51	35.5	05.4	76.1	47.6	19.9	93.2	67.3	42.5	18.7	96.0	51
52	36.7	06.6	77.3	48.8	21.1	94.4	68.6	43.7	20.0	97.3	52
53	37.8	07.8	78.5	50.0	22.4	95.6	69.8	45.0	21.2	98.5	53
54	39.0	08.9	79.7	51.2	23.6	96.9	71.1	46.3	22.5	99.8	54
55	1940.2	2010.1	2080.8	2152.4	2224.8	2298.1	2372.3	2447.5	2523.8	2601.1	**55**
56	41.3	11.3	82.0	53.6	26.0	99.3	73.6	48.8	25.1	02.4	56
57	42.5	12.5	83.2	54.8	27.2	2300.5	74.8	50.1	26.4	03.7	57
58	43.6	13.6	84.4	56.0	28.4	01.8	76.1	51.3	27.6	05.0	58
59	44.8	14.8	85.6	57.2	29.6	03.0	77.3	52.6	28.9	06.3	59
60	1946.0	2016.0	2086.8	2158.4	2230.9	2304.2	2378.5	2453.8	2530.2	2607.6	**60**
′	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	′

′	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	′
0	2607.6	2686.2	2766.0	2847.1	2929.5	3013.4	3098.7	3185.6	3274.1	3364.4	**0**
1	08.9	87.6	67.4	48.5	30.9	14.8	3100.1	87.1	75.6	65.9	1
2	10.2	88.9	68.7	49.9	32.3	16.2	01.6	88.5	77.1	67.4	2
3	11.5	90.2	70.1	51.2	33.7	17.6	03.0	90.0	78.6	69.0	3
4	12.8	91.5	71.4	52.6	35.1	19.0	04.4	91.4	80.1	70.5	4
5	2614.1	2692.8	2772.8	2853.9	2936.5	3020.4	3105.9	3192.9	3281.6	3372.0	**5**
6	15.4	94.2	74.1	55.3	37.9	21.8	07.3	94.4	83.1	73.5	6
7	16.8	95.5	75.4	56.7	39.3	23.3	08.8	95.8	84.6	75.1	7
8	18.1	96.8	76.8	58.0	40.6	24.7	10.2	97.3	86.1	76.6	8
9	19.4	98.1	78.1	59.4	42.0	26.1	11.6	98.8	87.6	78.1	9
10	2620.7	2699.5	2779.5	2860.8	2943.4	3027.5	3113.1	3200.2	3289.0	3379.6	**10**
11	22.0	2700.8	80.8	62.1	44.8	28.9	14.5	01.7	90.5	81.2	11
12	23.3	02.1	82.2	63.5	46.2	30.3	16.0	03.2	92.0	82.7	12
13	24.6	03.4	83.5	64.9	47.6	31.7	17.4	04.6	93.5	84.2	13
14	25.9	04.8	84.8	66.2	49.0	33.2	18.8	06.1	95.0	85.7	14
15	2627.2	2706.1	2786.2	2867.6	2950.4	3034.6	3120.3	3207.6	3296.5	3387.3	**15**
16	28.5	07.4	87.5	69.0	51.8	36.0	21.7	09.0	98.0	88.8	16
17	29.8	08.7	88.9	70.3	53.2	37.4	23.2	10.5	99.5	90.3	17
18	31.1	10.1	90.2	71.7	54.5	38.8	24.6	12.0	3301.0	91.8	18
19	32.4	11.4	91.6	73.1	55.9	40.2	26.0	13.4	02.5	93.4	19
20	2633.7	2712.7	2792.9	2874.4	2957.3	3041.7	3127.5	3214.9	3304.0	3394.9	**20**
21	35.0	14.0	94.3	75.8	58.7	43.1	28.9	16.4	05.5	96.4	21
22	36.3	15.4	95.6	77.2	60.1	44.5	30.4	17.9	07.0	98.0	22
23	37.6	16.7	97.0	78.6	61.5	45.9	31.8	19.3	08.5	99.5	23
24	38.9	18.0	98.3	79.9	62.9	47.3	33.3	20.8	10.0	3401.0	24
25	2640.2	2719.3	2799.7	2881.3	2964.3	3048.7	3134.7	3222.3	3311.5	3402.6	**25**
26	41.6	20.7	2801.0	82.7	65.7	50.2	36.2	23.7	13.0	04.1	26
27	42.9	22.0	02.4	84.0	67.1	51.6	37.6	25.2	14.5	05.6	27
28	44.2	23.3	03.7	85.4	68.5	53.0	39.0	26.7	16.0	07.2	28
29	45.5	24.7	05.1	86.8	69.9	54.4	40.5	28.2	17.5	08.7	29
30	2646.8	2726.0	2806.4	2888.2	2971.3	3055.9	3141.9	3229.6	3319.0	3410.2	**30**
31	48.1	27.3	07.8	89.5	72.7	57.3	43.4	31.1	20.5	11.8	31
32	49.4	28.6	09.1	90.9	74.1	58.7	44.8	32.6	22.1	13.3	32
33	50.7	30.0	10.5	92.3	75.5	60.1	46.3	34.1	23.6	14.8	33
34	52.0	31.3	11.8	93.7	76.9	61.5	47.7	35.6	25.1	16.4	34
35	2653.3	2732.6	2813.2	2895.0	2978.3	3063.0	3149.2	3237.0	3326.6	3417.9	**35**
36	54.7	34.0	14.5	96.4	79.7	64.4	50.6	38.5	28.1	19.5	36
37	56.0	35.3	15.9	97.8	81.1	65.8	52.1	40.0	29.6	21.0	37
38	57.3	36.6	17.2	99.2	82.5	67.2	53.5	41.5	31.1	22.5	38
39	58.6	38.0	18.6	2900.5	83.9	68.7	55.0	42.9	32.6	24.1	39
40	2659.9	2739.3	2820.0	2901.9	2985.3	3070.1	3156.4	3244.4	3334.1	3425.6	**40**
41	61.2	40.6	21.3	03.3	86.7	71.5	57.9	45.9	35.6	27.2	41
42	62.5	42.0	22.7	04.7	88.1	72.9	59.4	47.4	37.1	28.7	42
43	63.9	43.3	24.0	06.1	89.5	74.4	60.8	48.9	38.6	30.2	43
44	65.2	44.6	25.4	07.4	90.9	75.8	62.3	50.3	40.2	31.8	44
45	2666.5	2746.0	2826.7	2908.8	2992.3	3077.2	3163.7	3251.8	3341.7	3433.3	**45**
46	67.8	47.3	28.1	10.2	93.7	78.7	65.2	53.3	43.2	34.9	46
47	69.1	48.6	29.4	11.6	95.1	80.1	66.6	54.8	44.7	36.4	47
48	70.4	50.0	30.8	13.0	96.5	81.5	68.1	56.3	46.2	38.0	48
49	71.7	51.3	32.2	14.3	97.9	82.9	69.5	57.8	47.7	39.5	49
50	2673.1	2752.7	2833.5	2915.7	2999.3	3084.4	3171.0	3259.3	3349.2	3441.0	**50**
51	74.4	54.0	34.9	17.1	3000.7	85.8	72.5	60.7	50.8	42.6	51
52	75.7	55.3	36.2	18.5	02.1	87.2	73.9	62.2	52.3	44.1	52
53	77.0	56.7	37.6	19.9	03.5	88.7	75.4	63.7	53.8	45.7	53
54	78.3	58.0	39.0	21.2	04.9	90.1	76.8	65.2	55.3	47.2	54
55	2679.6	2759.3	2840.3	2922.6	3006.3	3091.5	3178.3	3266.7	3356.8	3448.8	**55**
56	81.0	60.7	41.7	24.0	07.7	93.0	79.7	68.2	58.3	50.3	56
57	82.3	62.0	43.0	25.4	09.2	94.4	81.2	69.7	59.9	51.9	57
58	83.6	63.4	44.4	26.8	10.6	95.8	82.7	71.1	61.4	53.4	58
59	84.9	64.7	45.8	28.2	12.0	97.3	84.1	72.6	62.9	55.0	59
60	2686.2	2766.0	2847.1	2929.5	3013.4	3098.7	3185.6	3274.1	3364.4	3456.5	**60**
′	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	′

′	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	′
0	3456.5	3550.6	3646.7	3745.1	3845.7	3948.8	4054.5	4163.0	4274.4	4389.1	**0**
1	58.1	52.2	48.4	46.7	47.4	50.5	56.3	64.8	76.3	91.0	1
2	59.6	53.8	50.0	48.4	49.1	52.3	58.1	66.6	78.2	92.9	2
3	61.2	55.4	51.6	50.0	50.8	54.0	59.8	68.5	80.1	94.9	3
4	62.7	56.9	53.2	51.7	52.5	55.7	61.6	70.3	82.0	96.8	4
5	3464.3	3558.5	3654.8	3753.4	3854.2	3957.5	4063.4	4172.1	4283.9	4398.8	**5**
6	65.9	60.1	56.5	55.0	55.9	59.2	65.2	74.0	85.7	4400.7	6
7	67.4	61.7	58.1	56.7	57.6	61.0	67.0	75.8	87.6	02.6	7
8	69.0	63.3	59.7	58.3	59.3	62.7	68.8	77.7	89.5	04.6	8
9	70.5	64.9	61.3	60.0	61.0	64.5	70.6	79.5	91.4	06.5	9
10	3472.1	3566.5	3663.0	3761.7	3862.7	3966.2	4072.4	4181.3	4293.3	4408.5	**10**
11	73.6	68.1	64.6	63.3	64.4	68.0	74.2	83.2	95.2	10.4	11
12	75.2	69.7	66.2	65.0	66.1	69.7	76.0	85.0	97.1	12.4	12
13	76.7	71.3	67.9	66.7	67.8	71.5	77.7	86.9	99.0	14.3	13
14	78.3	72.8	69.5	68.3	69.5	73.2	79.5	88.7	4300.9	16.3	14
15	3479.9	3574.4	3671.1	3770.0	3871.2	3975.0	4081.3	4190.6	4302.8	4418.2	**15**
16	81.4	76.0	72.7	71.7	72.9	76.7	83.1	92.4	04.7	20.2	16
17	83.0	77.6	74.4	73.3	74.6	78.5	84.9	94.2	06.6	22.1	17
18	84.5	79.2	76.0	75.0	76.3	80.2	86.7	96.1	08.5	24.1	18
19	86.1	80.8	77.6	76.7	78.1	82.0	88.5	97.9	10.4	26.1	19
20	3487.7	3582.4	3679.3	3778.3	3879.8	3983.7	4090.3	4199.8	4312.3	4428.0	**20**
21	89.2	84.0	80.9	80.0	81.5	85.5	92.1	4201.6	14.2	30.0	21
22	90.8	85.6	82.5	81.7	83.2	87.2	93.9	03.5	16.1	31.9	22
23	92.4	87.2	84.2	83.3	84.9	89.0	95.7	05.3	18.0	33.9	23
24	93.9	88.8	85.8	85.0	86.6	90.7	97.5	07.2	19.9	35.8	24
25	3495.5	3590.4	3687.4	3786.7	3888.3	3992.5	4099.3	4209.0	4321.8	4437.8	**25**
26	97.1	92.0	89.1	88.4	90.0	94.3	4101.1	10.9	23.7	39.8	26
27	98.6	93.6	90.7	90.0	91.8	96.0	02.9	12.8	25.6	41.7	27
28	3500.2	95.2	92.3	91.7	93.5	97.8	04.8	14.6	27.5	43.7	28
29	01.8	96.8	94.0	93.4	95.2	99.5	06.6	16.5	29.4	45.7	29
30	3503.3	3598.4	3695.6	3795.1	3896.9	4001.3	4108.4	4218.3	4331.3	4447.6	**30**
31	04.9	3600.0	97.3	96.8	98.6	03.1	10.2	20.2	33.2	49.6	31
32	06.5	01.6	98.9	98.4	3900.4	04.8	12.0	22.0	35.2	51.6	32
33	08.0	03.2	3700.5	3800.1	02.1	06.6	13.8	23.9	37.1	53.5	33
34	09.6	04.8	02.2	01.8	03.8	08.3	15.6	25.8	39.0	55.5	34
35	3511.2	3606.4	3703.8	3803.5	3905.5	4010.1	4117.4	4227.6	4340.9	4457.5	**35**
36	12.7	08.0	05.5	05.1	07.2	11.9	19.2	29.5	42.8	59.4	36
37	14.3	09.6	07.1	06.8	09.0	13.6	21.0	31.3	44.7	61.4	37
38	15.9	11.2	08.7	08.5	10.7	15.4	22.9	33.2	46.6	63.4	38
39	17.5	12.8	10.4	10.2	12.4	17.2	24.7	35.1	48.6	65.4	39
40	3519.0	3614.5	3712.0	3811.9	3914.1	4018.9	4126.5	4236.9	4350.5	4467.3	**40**
41	20.6	16.1	13.7	13.6	15.9	20.7	28.3	38.8	52.4	69.3	41
42	22.2	17.7	15.3	15.2	17.6	22.5	30.1	40.7	54.3	71.3	42
43	23.7	19.3	17.0	17.0	19.3	24.3	31.9	42.5	56.2	73.3	43
44	25.3	20.9	18.6	18.6	21.0	26.0	33.8	44.4	58.2	75.3	44
45	3526.9	3622.5	3720.3	3820.3	3922.8	4027.8	4135.6	4246.3	4360.1	4477.2	**45**
46	28.5	24.1	21.9	22.0	24.5	29.6	37.4	48.1	62.0	79.2	46
47	30.1	25.7	23.6	23.7	26.2	31.4	39.2	50.0	63.9	81.2	47
48	31.6	27.3	25.2	25.4	28.0	33.1	41.0	51.9	65.9	83.2	48
49	33.2	29.0	26.9	27.1	29.7	34.9	42.9	53.8	67.8	85.2	49
50	3534.8	3630.6	3728.5	3828.7	3931.4	4036.7	4144.7	4255.6	4369.7	4487.2	**50**
51	36.4	32.2	30.2	30.4	33.2	38.5	46.5	57.5	71.7	89.1	51
52	37.9	33.8	31.8	32.1	34.9	40.2	48.3	59.4	73.6	91.1	52
53	39.5	35.4	33.5	33.8	36.6	42.0	50.2	61.3	75.5	93.1	53
54	41.1	37.0	35.1	35.5	38.4	43.8	52.0	63.1	77.4	95.1	54
55	3542.7	3638.6	3736.8	3837.2	3940.1	4045.6	4153.8	4265.0	4379.4	4497.1	**55**
56	44.3	40.3	38.4	38.9	41.8	47.4	55.7	66.9	81.3	99.1	56
57	45.9	41.9	40.1	40.6	43.6	49.1	57.5	68.8	83.2	4501.1	57
58	47.4	43.5	41.7	42.3	45.3	50.9	59.3	70.7	85.2	03.1	58
59	49.0	45.1	43.4	45.0	47.0	52.7	61.1	72.5	87.1	05.1	59
60	3550.6	3646.7	3745.1	3845.7	3948.8	4054.5	4163.0	4274.4	4389.1	4507.1	**60**
′	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	′

Table 6

Combined Correction for Observed Sextant Altitudes

Observed Altitude	Correction	
	For **Sun** (to be **added** to observed altitude)	For **Star** (to be **subtracted** from observed altitude)
5°	6′ 14″	9′ 55″
6	7 41	8 28
7	8 45	7 24
8	9 35	6 34
9	10 16	5 53
10	10 50	5 19
11	11 17	4 51
12	11 41	4 27
13	12 2	4 7
14	12 19	3 49
15	12 34	3 34
20	13 29	2 39
25	14 3	2 5
30	14 26	1 41
35	14 44	1 23
40	14 57	1 10
45	15 8	0 58
50	15 17	0 49
55	15 25	0 40
60	15 31	0 34
65	15 37	0 27
70	15 42	0 21
75	15 47	0 16
80	15 52	0 10
85	15 55	0 5

Small supplementary correction, for Sun only.

Jan. to March and Oct. to Dec. } add 10″.
April to Sept., subtract 10″.

Table 7

Correction for Dip of Sea Horizon (Sun or Star)

Height of Observer's Eye Above Sea Level (feet)	Dip Correction (to be **subtracted** from observed altitude)
4	1′ 58″
6	2 24
8	2 46
10	3 06
12	3 24
14	3 40
16	3 55
18	4 9
20	4 23
22	4 36
24	4 48
26	5 0
28	5 11
30	5 22
35	5 48
40	6 12
45	6 36
50	6 56
55	7 16
60	7 35
70	8 12
85	9 2
100	9 48

The dip correction is not required when the artificial horizon is used.

Table 8

To Change Hours and Minutes into Decimals of a Day

HOURS EXPRESSED AS DECIMAL PARTS OF A DAY

Hours	Decimal
1	.0416
2	.0833
3	.1250
4	.1666
5	.2083
6	.2500
7	.2916
8	.3333
9	.3750
10	.4166
11	.4583
12	.5000
13	.5416
14	.5833
15	.6249
16	.6666
17	.7083
18	.7500
19	.7916
20	.8333
21	.8749
22	.9166
23	.9583
24	1.0000

MINUTES EXPRESSED AS DECIMAL PARTS OF A DAY

Minutes	Decimal	Minutes	Decimal
1	.0006	31	.0215
2	.0013	32	.0222
3	.0020	33	.0229
4	.0027	34	.0236
5	.0034	35	.0243
6	.0041	36	.0250
7	.0048	37	.0256
8	.0055	38	.0263
9	.0062	39	.0270
10	.0069	40	.0277
11	.0076	41	.0284
12	.0083	42	.0291
13	.0090	43	.0298
14	.0097	44	.0305
15	.0104	45	.0312
16	.0111	46	.0319
17	.0118	47	.0326
18	.0125	48	.0333
19	.0131	49	.0340
20	.0138	50	.0347
21	.0145	51	.0354
22	.0152	52	.0361
23	.0159	53	.0368
24	.0166	54	.0375
25	.0173	55	.0381
26	.0180	56	.0388
27	.0187	57	.0395
28	.0194	58	.0402
29	.0201	59	.0409
30	.0208	60	.0416

Table 9

To Interchange Degrees and Minutes of Longitude and Hours, Minutes, and Seconds of Time. Part 1

	0^h	1^h	2^h	3^h	4^h	5^h	6^h	7^h	8^h	9^h	10^h	11^h
0^m	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°
4	1	16	31	46	61	76	91	106	121	136	151	166
8	2	17	32	47	62	77	92	107	122	137	152	167
12	3	18	33	48	63	78	93	108	123	138	153	168
16	4	19	34	49	64	79	94	109	124	139	154	169
20	5	20	35	50	65	80	95	110	125	140	155	170
24	6	21	36	51	66	81	96	111	126	141	156	171
28	7	22	37	52	67	82	97	112	127	142	157	172
32	8	23	38	53	68	83	98	113	128	143	158	173
36	9	24	39	54	69	84	99	114	129	144	159	174
40	10	25	40	55	70	85	100	115	130	145	160	175
44	11	26	41	56	71	86	101	116	131	146	161	176
48	12	27	42	57	72	87	102	117	132	147	162	177
52	13	28	43	58	73	88	103	118	133	148	163	178
56	14	29	44	59	74	89	104	119	134	149	164	179

	12^h	13^h	14^h	15^h	16^h	17^h	18^h	19^h	20^h	21^h	22^h	23^h
0^m	180°	195°	210°	225°	240°	255°	270°	285°	300°	315°	330°	345°
4	181	196	211	226	241	256	271	286	301	316	331	346
8	182	197	212	227	242	257	272	287	302	317	332	347
12	183	198	213	228	243	258	273	288	303	318	333	348
16	184	199	214	229	244	259	274	289	304	319	334	349
20	185	200	215	230	245	260	275	290	305	320	335	350
24	186	201	216	231	246	261	276	291	306	321	336	351
28	187	202	217	232	247	262	277	292	307	322	337	352
32	188	203	218	233	248	263	278	293	308	323	338	353
36	189	204	219	234	249	264	279	294	309	324	339	354
40	190	205	220	235	250	265	280	295	310	325	340	355
44	191	206	221	236	251	266	281	296	311	326	341	356
48	192	207	222	237	252	267	282	297	312	327	342	357
52	193	208	223	238	253	268	283	298	313	328	343	358
56	194	209	224	239	254	269	284	299	314	329	344	359

Part 2

	0^m	1^m	2^m	3^m
0^s	0′	15′	30′	45′
4	1	16	31	46
8	2	17	32	47
12	3	18	33	48
16	4	19	34	49
20	5	20	35	50
24	6	21	36	51
28	7	22	37	52
32	8	23	38	53
36	9	24	39	54
40	10	25	40	55
44	11	26	41	56
48	12	27	42	57
52	13	28	43	58
56	14	29	44	59

Explanation of Table 9

1. To change degrees of longitude into hours and minutes of time: Find the number of degrees in Part 1. The required hours will then be found at the head of the column containing the degrees, and the required minutes at the left-hand end of the line containing the degrees.

Examples: 113° = $7^h 32^m$; 294° = $19^h 36^m$.

2. To change minutes of longitude into minutes and seconds of time: Find the minutes of longitude in Part 2. The required minutes and seconds of time will again be found at the head of the column and the left-hand end of the line.

Examples: 43′ = $2^m 52^s$; 28′ = $1^m 52^s$.

3. **1** and **2** can be combined by addition.

Examples: 113° 43′ = $7^h 34^m 52^s$.
294° 28′ = $19^h 37^m 52^s$.

4. To change hours and minutes of time into degrees and minutes of longitude: Find the number of hours at the head of one of the columns of Part 1; then run down the column until you reach a line having at its left-hand end a number of minutes equal to (or just smaller than) the given number of minutes of time. Where that line and column meet you will find the required degrees of longitude.

Examples: $7^h 32^m$ = 113°; $19^h 36^m$ = 294°.

5. To change minutes and seconds of time into minutes of longitude: Find the number of minutes of time at the head of one of the columns of Part 2; then run down the column until you reach a line having at its left-hand end a number of seconds equal (or nearly equal) to the given number of seconds of time. Where that line and column meet you will find the minutes of longitude.

Examples: $2^m 52^s$ = 43′; $1^m 52^s$ = 28′.

6. **4** and **5** can be combined by addition:

Examples: $7^s 34^m 52^s$ = 113° 43′; $19^h 37^m 52^s$ = 294° 28′.

Table 10. Haversine Table

s	′	$0^h\ 0^m$	0°	$0^h\ 4^m$	1°	$0^h\ 8^m$	2°	$0^h\ 12^m$	3°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**		**0.00000**	5.88168	**0.00008**	6.48371	**0.00030**	6.83584	**0.00069**
4	**1**	2.32539	**.00000**	.89604	**.00008**	.49092	**.00031**	.84065	**.00069**
8	**2**	.92745	**.00000**	.91016	**.00008**	.49807	**.00031**	.84543	**.00070**
12	**3**	3.27963	**.00000**	.92406	**.00008**	.50516	**.00032**	.85019	**.00071**
16	**4**	.52951	**.00000**	.93774	**.00009**	.51219	**.00033**	.85492	**.00072**
20	**5**	3.72333	**0.00000**	5.95121	**0.00009**	6.51916	**0.00033**	6.85963	**0.00072**
24	**6**	.88169	**.00000**	.96447	**.00009**	.52608	**.00034**	.86431	**.00073**
28	**7**	4.01559	**.00000**	.97753	**.00010**	.53295	**.00034**	.86897	**.00074**
32	**8**	.13157	**.00000**	.99040	**.00010**	.53976	**.00035**	.87360	**.00075**
36	**9**	.23388	**.00000**	6.00308	**.00010**	.54652	**.00035**	.87821	**.00076**
40	**10**	4.32539	**0.00000**	6.01557	**0.00010**	6.55323	**0.00036**	6.88279	**0.00076**
44	**11**	.40818	**.00000**	.02789	**.00011**	.55988	**.00036**	.88735	**.00077**
48	**12**	.48375	**.00000**	.04004	**.00011**	.56649	**.00037**	.89188	**.00078**
52	**13**	.55328	**.00000**	.05202	**.00011**	.57304	**.00037**	.89639	**.00079**
56	**14**	.61765	**.00000**	.06384	**.00012**	.57955	**.00038**	.90088	**.00080**
s	′	$0^h\ 1^m$	0°	$0^h\ 5^m$	1°	$0^h\ 9^m$	2°	$0^h\ 13^m$	3°
0	**15**	4.67757	**0.00000**	6.07550	**0.00012**	6.58600	**0.00039**	6.90535	**0.00080**
4	**16**	.73363	**.00001**	.08700	**.00012**	.59241	**.00039**	.90979	**.00081**
8	**17**	.78629	**.00001**	.09836	**.00013**	.59878	**.00040**	.91421	**.00082**
12	**18**	.83594	**.00001**	.10956	**.00013**	.60509	**.00040**	.91860	**.00083**
16	**19**	.88290	**.00001**	.12063	**.00013**	.61136	**.00041**	.92298	**.00084**
20	**20**	4.92745	**0.00001**	6.13155	**0.00014**	6.61759	**0.00041**	6.92733	**0.00085**
24	**21**	.96983	**.00001**	.14234	**.00014**	.62377	**.00042**	.93166	**.00085**
28	**22**	5.01024	**.00001**	.15300	**.00014**	.62991	**.00043**	.93597	**.00086**
32	**23**	.04885	**.00001**	.16353	**.00015**	.63600	**.00043**	.94026	**.00087**
36	**24**	.08581	**.00001**	.17393	**.00015**	.64205	**.00044**	.94453	**.00088**
40	**25**	5.12127	**0.00001**	6.18421	**0.00015**	6.64806	**0.00044**	6.94877	**0.00089**
44	**26**	.15534	**.00001**	.19437	**.00016**	.65403	**.00045**	.95300	**.00090**
48	**27**	.18812	**.00002**	.20441	**.00016**	.65996	**.00046**	.95720	**.00091**
52	**28**	.21971	**.00002**	.21433	**.00016**	.66585	**.00046**	.96139	**.00091**
56	**29**	.25019	**.00002**	.22415	**.00017**	.67170	**.00047**	.96555	**.00092**
s	′	$0^h\ 2^m$	0°	$0^h\ 6^m$	1°	$0^h\ 10^m$	2°	$0^h\ 14^m$	3°
0	**30**	5.27963	**0.00002**	6.23385	**0.00017**	6.67751	**0.00048**	6.96970	**0.00093**
4	**31**	.30811	**.00002**	.24345	**.00018**	.68328	**.00048**	.97382	**.00094**
8	**32**	.33569	**.00002**	.25294	**.00018**	.68901	**.00049**	.97793	**.00095**
12	**33**	.36242	**.00002**	.26233	**.00018**	.69470	**.00050**	.98201	**.00096**
16	**34**	.38835	**.00002**	.27162	**.00019**	.70036	**.00050**	.98608	**.00097**
20	**35**	5.41352	**0.00003**	6.28081	**0.00019**	6.70598	**0.00051**	6.99013	**0.00098**
24	**36**	.43799	**.00003**	.28991	**.00019**	.71157	**.00051**	.99416	**.00099**
28	**37**	.46179	**.00003**	.29891	**.00020**	.71712	**.00052**	.99817	**.00100**
32	**38**	.48496	**.00003**	.30781	**.00020**	.72263	**.00053**	7.00216	**.00101**
36	**39**	.50752	**.00003**	.31663	**.00021**	.72811	**.00053**	.00613	**.00101**
40	**40**	5.52951	**0.00003**	6.32536	**0.00021**	6.73355	**0.00054**	7.01009	**0.00102**
44	**41**	.55095	**.00004**	.33400	**.00022**	.73896	**.00055**	.01403	**.00103**
48	**42**	.57189	**.00004**	.34256	**.00022**	.74434	**.00056**	.01795	**.00104**
52	**43**	.59232	**.00004**	.35103	**.00022**	.74969	**.00056**	.02185	**.00105**
56	**44**	.61229	**.00004**	.35943	**.00023**	.75500	**.00057**	.02573	**.00106**
s	′	$0^h\ 3^m$	0°	$0^h\ 7^m$	1°	$0^h\ 11^m$	2°	$0^h\ 15^m$	3°
0	**45**	5.63181	**0.00004**	6.36774	**0.00023**	6.76028	**0.00058**	7.02960	**0.00107**
4	**46**	.65090	**.00004**	.37597	**.00024**	.76552	**.00058**	.03345	**.00108**
8	**47**	.66958	**.00005**	.38412	**.00024**	.77074	**.00059**	.03729	**.00109**
12	**48**	.68787	**.00005**	.39220	**.00025**	.77592	**.00060**	.04110	**.00110**
16	**49**	.70578	**.00005**	.40021	**.00025**	.78108	**.00060**	.04490	**.00111**
20	**50**	5.72332	**0.00005**	6.40814	**0.00026**	6.78620	**0.00061**	7.04869	**0.00112**
24	**51**	.74052	**.00006**	.41600	**.00026**	.79129	**.00062**	.05245	**.00113**
28	**52**	.75739	**.00006**	.42379	**.00027**	.79630	**.00063**	.05620	**.00114**
32	**53**	.77394	**.00006**	.43151	**.00027**	.80139	**.00063**	.05994	**.00115**
36	**54**	.79017	**.00006**	.43916	**.00027**	.80640	**.00064**	.06366	**.00116**
40	**55**	5.80611	**0.00006**	6.44675	**0.00028**	6.81137	**0.00065**	7.06736	**0.00117**
44	**56**	.82176	**.00007**	.45427	**.00028**	.81632	**.00066**	.07105	**.00118**
48	**57**	.83713	**.00007**	.46172	**.00029**	.82124	**.00066**	.07472	**.00119**
52	**58**	.85224	**.00007**	.46911	**.00029**	.82614	**.00067**	.07837	**.00120**
56	**59**	.86709	**.00007**	.47644	**.00030**	.83100	**.00068**	.08201	**.00121**
60	**60**	5.88168	**0.00008**	6.48371	**0.00030**	6.83584	**0.00069**	7.08564	**0.00122**

s	′	$0^h\ 16^m$ Hav.	4° No.	$0^h\ 20^m$ Hav.	5° No.	$0^h\ 24^m$ Hav.	6° No.	$0^h\ 28^m$ Hav.	7° No.
0	**0**	7.08564	**0.00122**	7.27936	**0.00190**	7.43760	**0.00274**	7.57135	**0.00373**
4	**1**	.08925	**.00123**	.28225	**.00192**	.44001	**.00275**	.57341	**.00374**
8	**2**	.09284	**.00124**	.28513	**.00193**	.44241	**.00277**	.57547	**.00376**
12	**3**	.09642	**.00125**	.28800	**.00194**	.44480	**.00278**	.57752	**.00378**
16	**4**	.09999	**.00126**	.29086	**.00195**	.44719	**.00280**	.57957	**.00380**
20	**5**	7.10354	**0.00127**	7.29371	**0.00197**	7.44957	**0.00282**	7.58162	**0.00382**
24	**6**	.10708	**.00128**	.29655	**.00198**	.45194	**.00283**	.58366	**.00383**
28	**7**	.11060	**.00129**	.29938	**.00199**	.45431	**.00285**	.58569	**.00385**
32	**8**	.11411	**.00130**	.30220	**.00201**	.45667	**.00286**	.58772	**.00387**
36	**9**	.11760	**.00131**	.30502	**.00202**	.45903	**.00288**	.58974	**.00389**
40	**10**	7.12108	**0.00132**	7.30782	**0.00203**	7.46138	**0.00289**	7.59176	**0.00391**
44	**11**	.12455	**.00133**	.31062	**.00204**	.46372	**.00291**	.59378	**.00392**
48	**12**	.12800	**.00134**	.31340	**.00206**	.46605	**.00292**	.59579	**.00394**
52	**13**	.13144	**.00135**	.31618	**.00207**	.46838	**.00294**	.59779	**.00396**
56	**14**	.13486	**.00136**	.31895	**.00208**	.47071	**.00296**	.59979	**.00398**
s	′	$0^h\ 17^m$	4°	$0^h\ 21^m$	5°	$0^h\ 25^m$	6°	$0^h\ 29^m$	7°
0	**15**	7.13827	**0.00137**	7.32171	**0.00210**	7.47302	**0.00297**	7.60179	**0.00400**
4	**16**	.14167	**.00139**	.32446	**.00211**	.47533	**.00299**	.60378	**.00402**
8	**17**	.14506	**.00140**	.32720	**.00212**	.47764	**.00300**	.60577	**.00403**
12	**18**	.14843	**.00141**	.32994	**.00214**	.47994	**.00302**	.60775	**.00405**
16	**19**	.15179	**.00142**	.33266	**.00215**	.48223	**.00304**	.60973	**.00407**
20	**20**	7.15513	**0.00143**	7.33538	**0.00216**	7.48452	**0.00305**	7.61170	**0.00409**
24	**21**	.15846	**.00144**	.33809	**.00218**	.48680	**.00307**	.61367	**.00411**
28	**22**	.16178	**.00145**	.34079	**.00219**	.48907	**.00308**	.61564	**.00413**
32	**23**	.16509	**.00146**	.34348	**.00221**	.49134	**.00310**	.61760	**.00415**
36	**24**	.16839	**.00147**	.34616	**.00222**	.49360	**.00312**	.61955	**.00416**
40	**25**	7.17167	**0.00148**	7.34884	**0.00223**	7.49586	**0.00313**	7.62151	**0.00418**
44	**26**	.17494	**.00150**	.35150	**.00225**	.49811	**.00315**	.62345	**.00420**
48	**27**	.17820	**.00151**	.35416	**.00226**	.50036	**.00316**	.62540	**.00422**
52	**28**	.18144	**.00152**	.35681	**.00227**	.50259	**.00318**	.62733	**.00424**
56	**29**	.18468	**.00153**	.35945	**.00229**	.50483	**.00320**	.62927	**.00426**
s	′	$0^h\ 18^m$	4°	$0^h\ 22^m$	5°	$0^h\ 26^m$	6°	$0^h\ 30^m$	7°
0	**30**	7.18790	**0.00154**	7.36209	**0.00230**	7.50706	**0.00321**	7.63120	**0.00428**
4	**31**	.19111	**.00155**	.36471	**.00232**	.50928	**.00323**	.63312	**.00430**
8	**32**	.19430	**.00156**	.36733	**.00233**	.51149	**.00325**	.63504	**.00432**
12	**33**	.19749	**.00158**	.36994	**.00234**	.51370	**.00326**	.63696	**.00433**
16	**34**	.20066	**.00159**	.37254	**.00236**	.51591	**.00328**	.63887	**.00435**
20	**35**	7.20383	**0.00160**	7.37514	**0.00237**	7.51811	**0.00330**	7.64078	**0.00437**
24	**36**	.20698	**.00161**	.37773	**.00239**	.52030	**.00331**	.64269	**.00439**
28	**37**	.21012	**.00162**	.38030	**.00240**	.52249	**.00333**	.64458	**.00441**
32	**38**	.21325	**.00163**	.38288	**.00241**	.52467	**.00335**	.64648	**.00443**
36	**39**	.21636	**.00165**	.38544	**.00243**	.52685	**.00336**	.64837	**.00445**
40	**40**	7.21947	**0.00166**	7.38800	**0.00244**	7.52902	**0.00338**	7.65026	**0.00447**
44	**41**	.22256	**.00167**	.39054	**.00246**	.53119	**.00340**	.65214	**.00449**
48	**42**	.22565	**.00168**	.39309	**.00247**	.53335	**.00341**	.65402	**.00451**
52	**43**	.22872	**.00169**	.39562	**.00249**	.53550	**.00343**	.65590	**.00453**
56	**44**	.23178	**.00171**	.39815	**.00250**	.53766	**.00345**	.65777	**.00455**
s	′	$0^h\ 19^m$	4°	$0^h\ 23^m$	5°	$0^h\ 27^m$	6°	$0^h\ 31^m$	7°
0	**45**	7.23483	**0.00172**	7.40067	**0.00252**	7.53980	**0.00347**	7.65964	**0.00457**
4	**46**	.23787	**.00173**	.40318	**.00253**	.54194	**.00348**	.66150	**.00459**
8	**47**	.24090	**.00174**	.40568	**.00255**	.54407	**.00350**	.66336	**.00461**
12	**48**	.24392	**.00175**	.40818	**.00256**	.54620	**.00352**	.66521	**.00463**
16	**49**	.24693	**.00177**	.41067	**.00257**	.54833	**.00353**	.66706	**.00465**
20	**50**	7.24993	**0.00178**	7.41315	**0.00259**	7.55045	**0.00355**	7.66891	**0.00467**
24	**51**	.25292	**.00179**	.41563	**.00260**	.55256	**.00357**	.67075	**.00469**
28	**52**	.25590	**.00180**	.41810	**.00262**	.55467	**.00359**	.67259	**.00471**
32	**53**	.25886	**.00181**	.42056	**.00263**	.55677	**.00360**	.67443	**.00473**
36	**54**	.26182	**.00183**	.42301	**.00265**	.55887	**.00362**	.67626	**.00475**
40	**55**	7.26477	**0.00184**	7.42546	**0.00266**	7.56096	**0.00364**	7.67809	**0.00477**
44	**56**	.26771	**.00185**	.42790	**.00268**	.56305	**.00366**	.67991	**.00479**
48	**57**	.27064	**.00186**	.43034	**.00269**	.56513	**.00367**	.68173	**.00481**
52	**58**	.27355	**.00188**	.43277	**.00271**	.56721	**.00369**	.68355	**.00483**
56	**59**	.27646	**.00189**	.43519	**.00272**	.56928	**.00371**	.68536	**.00485**
60	**60**	7.27936	**0.00190**	7.43760	**0.00274**	7.57135	**0.00373**	7.68717	**0.00487**

s	′	$0^h\,32^m$	8°	$0^h\,36^m$	9°	$0^h\,40^m$	10°	$0^h\,44^m$	11°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	7.68717	**0.00487**	7.78929	**0.00616**	7.88059	**0.00760**	7.96315	**0.00919**
4	**1**	.68897	**.00489**	.79089	**.00618**	.88203	**.00762**	.96446	**.00921**
8	**2**	.69077	**.00491**	.79249	**.00620**	.88348	**.00765**	.96577	**.00924**
12	**3**	.69257	**.00493**	.79409	**.00622**	.88491	**.00767**	.96707	**.00927**
16	**4**	.69437	**.00495**	.79568	**.00625**	.88635	**.00770**	.96838	**.00930**
20	**5**	7.69616	**0.00497**	7.79728	**0.00627**	7.88778	**0.00772**	7.96968	**0.00933**
24	**6**	.69794	**.00499**	.79886	**.00629**	.88921	**.00775**	.97098	**.00935**
28	**7**	.69972	**.00501**	.80045	**.00632**	.89064	**.00777**	.97228	**.00938**
32	**8**	.70150	**.00503**	.80203	**.00634**	.89207	**.00780**	.97358	**.00941**
36	**9**	.70328	**.00505**	.80361	**.00636**	.89349	**.00783**	.97478	**.00944**
40	**10**	7.70505	**0.00507**	7.80519	**0.00639**	7.89491	**0.00785**	7.97617	**0.00947**
44	**11**	.70682	**.00509**	.80677	**.00641**	.89633	**.00788**	.97746	**.00949**
48	**12**	.70858	**.00511**	.80834	**.00643**	.89775	**.00790**	.97875	**.00952**
52	**13**	.71034	**.00513**	.80991	**.00646**	.89916	**.00793**	.98003	**.00955**
56	**14**	.71210	**.00515**	.81147	**.00648**	.90057	**.00795**	.98132	**.00958**
s	′	$0^h\,33^m$	8°	$0^h\,37^m$	9°	$0^h\,41^m$	10°	$0^h\,45^m$	11°
0	**15**	7.71385	**0.00517**	7.81303	**0.00650**	7.90198	**0.00798**	7.98260	**0.00961**
4	**16**	.71560	**.00520**	.81459	**.00653**	.90339	**.00801**	.98389	**.00964**
8	**17**	.71735	**.00522**	.81615	**.00655**	.90480	**.00803**	.98517	**.00966**
12	**18**	.71909	**.00524**	.81771	**.00657**	.90620	**.00806**	.98644	**.00969**
16	**19**	.72083	**.00526**	.81926	**.00660**	.90760	**.00808**	.98772	**.00972**
20	**20**	7.72257	**0.00528**	7.82081	**0.00662**	7.90900	**0.00811**	7.98899	**0.00975**
24	**21**	.72430	**.00530**	.82235	**.00664**	.91039	**.00814**	.99027	**.00978**
28	**22**	.72603	**.00532**	.82390	**.00667**	.91179	**.00816**	.99154	**.00981**
32	**23**	.72775	**.00534**	.82544	**.00669**	.91318	**.00819**	.99281	**.00984**
36	**24**	.72948	**.00536**	.82698	**.00671**	.91457	**.00821**	.99407	**.00986**
40	**25**	7.73119	**0.00539**	7.82851	**0.00674**	7.91596	**0.00824**	7.99534	**0.00989**
44	**26**	.73291	**.00541**	.83004	**.00676**	.91734	**.00827**	.99660	**.00992**
48	**27**	.73462	**.00543**	.83157	**.00679**	.91872	**.00829**	.99786	**.00995**
52	**28**	.73633	**.00545**	.83310	**.00681**	.92010	**.00832**	.99912	**.00998**
56	**29**	.73803	**.00547**	.83463	**.00683**	.92148	**.00835**	8.00038	**.01001**
s	′	$0^h\,34^m$	8°	$0^h\,38^m$	9°	$0^h\,42^m$	10°	$0^h\,46^m$	11°
0	**30**	7.73974	**0.00549**	7.83615	**0.00686**	7.92286	**0.00837**	8.00163	**0.01004**
4	**31**	.74143	**.00551**	.83767	**.00688**	.92423	**.00840**	.00289	**.01007**
8	**32**	.74313	**.00554**	.83918	**.00691**	.92560	**.00843**	.00414	**.01010**
12	**33**	.74482	**.00556**	.84070	**.00693**	.92697	**.00845**	.00539	**.01012**
16	**34**	.74651	**.00558**	.84221	**.00695**	.92834	**.00848**	.00664	**.01015**
20	**35**	7.74819	**0.00560**	7.84372	**0.00698**	7.92970	**0.00851**	8.00788	**0.01018**
24	**36**	.74988	**.00562**	.84522	**.00700**	.93107	**.00853**	.00913	**.01021**
28	**37**	.75155	**.00564**	.84672	**.00703**	.93243	**.00856**	.01037	**.01024**
32	**38**	.75323	**.00567**	.84822	**.00705**	.93379	**.00859**	.01161	**.01027**
36	**39**	.75490	**.00569**	.84972	**.00707**	.93514	**.00861**	.01285	**.01030**
40	**40**	7.75657	**0.00571**	7.85122	**0.00710**	7.93650	**0.00864**	8.01409	**0.01033**
44	**41**	.75824	**.00573**	.85271	**.00712**	.93785	**.00867**	.01532	**.01036**
48	**42**	.75990	**.00575**	.85420	**.00715**	.93920	**.00869**	.01656	**.01039**
52	**43**	.76156	**.00578**	.85569	**.00717**	.94055	**.00872**	.01779	**.01042**
56	**44**	.76321	**.00580**	.85717	**.00720**	.94189	**.00875**	.01902	**.01045**
s	′	$0^h\,35^m$	8°	$0^h\,39^m$	9°	$0^h\,43^m$	10°	$0^h\,47^m$	11°
0	**45**	7.76487	**0.00582**	7.85866	**0.00722**	7.94324	**0.00877**	8.02025	**0.01048**
4	**46**	.76652	**.00584**	.86014	**.00725**	.94458	**.00880**	.02148	**.01051**
8	**47**	.76816	**.00586**	.86161	**.00727**	.94592	**.00883**	.02270	**.01054**
12	**48**	.76981	**.00589**	.86309	**.00730**	.94726	**.00886**	.02392	**.01057**
16	**49**	.77145	**.00591**	.86456	**.00732**	.94859	**.00888**	.02515	**.01060**
20	**50**	7.77308	**0.00593**	7.86603	**0.00735**	7.94992	**0.00891**	8.02637	**0.01063**
24	**51**	.77472	**.00595**	.86750	**.00737**	.95126	**.00894**	.02758	**.01066**
28	**52**	.77635	**.00598**	.86896	**.00740**	.95259	**.00897**	.02880	**.01069**
32	**53**	.77798	**.00600**	.87042	**.00742**	.95391	**.00899**	.03001	**.01072**
36	**54**	.77960	**.00602**	.87188	**.00745**	.95524	**.00902**	.03123	**.01075**
40	**55**	7.78122	**0.00604**	7.87334	**0.00747**	7.95656	**0.00905**	8.03244	**0.01078**
44	**56**	.78284	**.00607**	.87480	**.00750**	.95788	**.00908**	.03365	**.01081**
48	**57**	.78446	**.00609**	.87625	**.00752**	.95920	**.00910**	.03486	**.01084**
52	**58**	.78607	**.00611**	.87770	**.00755**	.96052	**.00913**	.03606	**.01087**
56	**59**	.78768	**.00613**	.87915	**.00757**	.96183	**.00916**	.03727	**.01090**
60	**60**	7.78929	**0.00616**	7.88059	**0.00760**	7.96315	**0.00919**	8.03847	**0.01093**

s	′	$0^h\,48^m$	12°	$0^h\,52^m$	13°	$0^h\,56^m$	14°	$1^h\,0^m$	15°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	8.03847	**0.01093**	8.10772	**0.01282**	8.17179	**0.01485**	8.23140	**0.01704**
4	**1**	.03967	**.01096**	.10883	**.01285**	.17282	**.01489**	.23235	**.01707**
8	**2**	.04087	**.01099**	.10993	**.01288**	.17384	**.01492**	.23331	**.01711**
12	**3**	.04207	**.01102**	.11104	**.01291**	.17487	**.01496**	.23427	**.01715**
16	**4**	.04326	**.01105**	.11214	**.01295**	.17590	**.01499**	.23523	**.01719**
20	**5**	8.04446	**0.01108**	8.11324	**0.01298**	8.17692	**0.01503**	8.23618	**0.01723**
24	**6**	.04565	**.01111**	.11435	**.01301**	.17794	**.01506**	.23713	**.01726**
28	**7**	.04684	**.01114**	.11544	**.01305**	.17896	**.01510**	.23809	**.01730**
32	**8**	.04803	**.01117**	.11654	**.01308**	.17998	**.01513**	.23904	**.01734**
36	**9**	.04922	**.01120**	.11764	**.01311**	.18100	**.01517**	.23999	**.01738**
40	**10**	8.05041	**0.01123**	8.11873	**0.01314**	8.18202	**0.01521**	8.24094	**0.01742**
44	**11**	.05159	**.01126**	.11983	**.01317**	.18303	**.01524**	.24189	**.01745**
48	**12**	.05277	**.01129**	.12092	**.01321**	.18405	**.01528**	.24283	**.01749**
52	**13**	.05395	**.01132**	.12201	**.01324**	.18506	**.01531**	.24378	**.01753**
56	**14**	.05513	**.01135**	.12310	**.01328**	.18607	**.01535**	.24473	**.01757**
s	′	$0^h\,49^m$	**12°**	$0^h\,53^m$	**13°**	$0^h\,57^m$	**14°**	$1^h\,1^m$	**15°**
0	**15**	8.05631	**0.01138**	8.12419	**0.01331**	8.18709	**0.01538**	8.24567	**0.01761**
4	**16**	.05749	**.01142**	.12528	**.01334**	.18810	**.01542**	.24661	**.01764**
8	**17**	.05866	**.01145**	.12636	**.01338**	.18910	**.01546**	.24755	**.01768**
12	**18**	.05984	**.01148**	.12745	**.01341**	.19011	**.01549**	.24850	**.01772**
16	**19**	.06101	**.01151**	.12853	**.01344**	.19112	**.01553**	.24944	**.01776**
20	**20**	8.06218	**0.01154**	8.12961	**0.01348**	8.19212	**0.01556**	8.25037	**0.01780**
24	**21**	.06335	**.01157**	.13069	**.01351**	.19313	**.01560**	.25131	**.01784**
28	**22**	.06451	**.01160**	.13177	**.01354**	.19413	**.01564**	.25225	**.01788**
32	**23**	.06568	**.01163**	.13285	**.01358**	.19513	**.01567**	.25319	**.01791**
36	**24**	.06684	**.01166**	.13392	**.01361**	.19613	**.01571**	.25412	**.01795**
40	**25**	8.06800	**0.01170**	8.13500	**0.01365**	8.19713	**0.01574**	8.25505	**0.01799**
44	**26**	.06917	**.01173**	.13607	**.01368**	.19813	**.01578**	.25599	**.01803**
48	**27**	.07032	**.01176**	.13714	**.01371**	.19913	**.01582**	.25692	**.01807**
52	**28**	.07148	**.01179**	.13822	**.01375**	.20012	**.01585**	.25785	**.01811**
56	**29**	.07264	**.01182**	.13928	**.01378**	.20112	**.01589**	.25878	**.01815**
s	′	$0^h\,50^m$	**12°**	$0^h\,54^m$	**13°**	$0^h\,58^m$	**14°**	$1^h\,2^m$	**15°**
0	**30**	8.07379	**0.01185**	8.14035	**0.01382**	8.20211	**0.01593**	8.25971	**0.01818**
4	**31**	.07494	**.01188**	.14142	**.01385**	.20310	**.01596**	.26064	**.01822**
8	**32**	.07610	**.01192**	.14248	**.01388**	.20410	**.01600**	.26156	**.01826**
12	**33**	.07725	**.01195**	.14355	**.01392**	.20509	**.01604**	.26249	**.01830**
16	**34**	.07839	**.01198**	.14461	**.01395**	.20608	**.01607**	.26341	**.01834**
20	**35**	8.07954	**0.01201**	8.14567	**0.01399**	8.20706	**0.01611**	8.26434	**0.01838**
24	**36**	.08069	**.01204**	.14673	**.01402**	.20805	**.01615**	.26526	**.01842**
28	**37**	.08183	**.01207**	.14779	**.01405**	.20904	**.01618**	.26618	**.01846**
32	**38**	.08297	**.01211**	.14885	**.01409**	.21002	**.01622**	.26710	**.01850**
36	**39**	.08411	**.01214**	.14991	**.01412**	.21100	**.01626**	.26802	**.01854**
40	**40**	8.08525	**0.01217**	8.15096	**0.01416**	8.21199	**0.01629**	8.26894	**0.01858**
44	**41**	.08639	**.01220**	.15201	**.01419**	.21297	**.01633**	.26986	**.01861**
48	**42**	.08752	**.01223**	.15307	**.01423**	.21395	**.01637**	.27078	**.01865**
52	**43**	.08866	**.01226**	.15412	**.01426**	.21493	**.01640**	.27169	**.01869**
56	**44**	.08979	**.01230**	.15517	**.01429**	.21590	**.01644**	.27261	**.01873**
s	′	$0^h\,51^m$	**12°**	$0^h\,55^m$	**13°**	$0^h\,59^m$	**14°**	$1^h\,3^m$	**15°**
0	**45**	8.09092	**0.01233**	8.15622	**0.01433**	8.21688	**0.01648**	8.27352	**0.01877**
4	**46**	.09205	**.01236**	.15726	**.01436**	.21785	**.01651**	.27443	**.01881**
8	**47**	.09318	**.01239**	.15831	**.01440**	.21883	**.01655**	.27534	**.01885**
12	**48**	.09431	**.01243**	.15935	**.01443**	.21980	**.01659**	.27626	**.01889**
16	**49**	.09543	**.01246**	.16040	**.01447**	.22077	**.01663**	.27717	**.01893**
20	**50**	8.09656	**0.01249**	8.16144	**0.01450**	8.22175	**0.01666**	8.27807	**0.01897**
24	**51**	.09768	**.01252**	.16248	**.01454**	.22272	**.01670**	.27898	**.01901**
28	**52**	.09880	**.01255**	.16352	**.01457**	.22368	**.01674**	.27989	**.01905**
32	**53**	.09992	**.01259**	.16456	**.01461**	.22465	**.01677**	.28080	**.01909**
36	**54**	.10104	**.01262**	.16559	**.01464**	.22562	**.01681**	.28170	**.01913**
40	**55**	8.10216	**0.01265**	8.16663	**0.01468**	8.22658	**0.01685**	8.28260	**0.01917**
44	**56**	.10327	**.01268**	.16766	**.01471**	.22755	**.01689**	.28351	**.01921**
48	**57**	.10439	**.01272**	.16870	**.01475**	.22851	**.01692**	.28441	**.01925**
52	**58**	.10550	**.01275**	.16973	**.01478**	.22947	**.01696**	.28531	**.01929**
56	**59**	.10661	**.01278**	.17076	**.01482**	.23044	**.01700**	.28621	**.01933**
60	**60**	8.10772	**0.01282**	8.17179	**0.01485**	8.23140	**0.01704**	8.28711	**0.01937**

Table 10. Haversine Table

s	′	1h 4m Hav.	16° No.	1h 8m Hav.	17° No.	1h 12m Hav.	18° No.	1h 16m Hav.	19° No.
0	0	8.28711	**0.01937**	8.33940	**0.02185**	8.38867	**0.02447**	8.43522	**0.02724**
4	1	.28801	**.01941**	.34025	**.02189**	.38946	**.02452**	.43597	**.02729**
8	2	.28891	**.01945**	.34109	**.02193**	.39026	**.02456**	.43673	**.02734**
12	3	.28980	**.01949**	.34194	**.02198**	.39105	**.02461**	.43748	**.02738**
16	4	.29070	**.01953**	.34278	**.02202**	.39185	**.02465**	.43823	**.02743**
20	5	8.29159	**0.01957**	8.34362	**0.02206**	8.39264	**0.02470**	8.43899	**0.02748**
24	6	.29249	**.01961**	.34446	**.02210**	.39344	**.02474**	.43974	**.02753**
28	7	.29338	**.01965**	.34530	**.02215**	.39423	**.02479**	.44049	**.02757**
32	8	.29427	**.01969**	.34614	**.02219**	.39502	**.02483**	.44124	**.02762**
36	9	.29516	**.01973**	.34698	**.02223**	.39581	**.02488**	.44199	**.02767**
40	10	8.29605	**0.01977**	8.34782	**0.02227**	8.39660	**0.02492**	8.44273	**0.02772**
44	11	.29694	**.01981**	.34865	**.02232**	.39739	**.02497**	.44348	**.02776**
48	12	.29783	**.01985**	.34949	**.02236**	.39818	**.02501**	.44423	**.02781**
52	13	.29872	**.01989**	.35032	**.02240**	.39897	**.02506**	.44498	**.02786**
56	14	.29960	**.01993**	.35116	**.02245**	.39976	**.02510**	.44572	**.02791**
s	′	1h 5m	16°	1h 9m	17°	1h 13m	18°	1h 17m	19°
0	15	8.30049	**0.01998**	8.35199	**0.02249**	8.40055	**0.02515**	8.44647	**0.02796**
4	16	.30137	**.02002**	.35282	**.02253**	.40133	**.02520**	.44721	**.02800**
8	17	.30226	**.02006**	.35365	**.02258**	.40212	**.02524**	.44796	**.02805**
12	18	.30314	**.02010**	.35449	**.02262**	.40290	**.02529**	.44870	**.02810**
16	19	.30402	**.02014**	.35532	**.02266**	.40369	**.02533**	.44944	**.02815**
20	20	8.30490	**0.02018**	8.35614	**0.02271**	8.40447	**0.02538**	8.45018	**0.02820**
24	21	.30578	**.02022**	.35697	**.02275**	.40525	**.02542**	.45093	**.02824**
28	22	.30666	**.02026**	.35780	**.02279**	.40603	**.02547**	.45167	**.02829**
32	23	.30754	**.02030**	.35863	**.02284**	.40681	**.02552**	.45241	**.02834**
36	24	.30842	**.02034**	.35945	**.02288**	.40760	**.02556**	.45315	**.02839**
40	25	8.30929	**0.02038**	8.36028	**0.02292**	8.40837	**0.02561**	8.45388	**0.02844**
44	26	.31017	**.02043**	.36110	**.02297**	.40915	**.02565**	.45462	**.02849**
48	27	.31104	**.02047**	.36193	**.02301**	.40993	**.02570**	.45536	**.02853**
52	28	.31192	**.02051**	.36275	**.02305**	.41071	**.02575**	.45610	**.02858**
56	29	.31279	**.02055**	.36357	**.02310**	.41149	**.02579**	.45683	**.02863**
s	′	1h 6m	16°	1h 10m	17°	1h 14m	18°	1h 18m	19°
0	30	8.31366	**0.02059**	8.36439	**0.02314**	8.41226	**0.02584**	8.45757	**0.02868**
4	31	.31453	**.02063**	.36521	**.02319**	.41304	**.02588**	.45830	**.02873**
8	32	.31540	**.02067**	.36603	**.02323**	.41381	**.02593**	.45904	**.02878**
12	33	.31627	**.02071**	.36685	**.02327**	.41459	**.02598**	.45977	**.02883**
16	34	.31714	**.02076**	.36767	**.02332**	.41536	**.02602**	.46050	**.02887**
20	35	8.31800	**0.02080**	8.36849	**0.02336**	8.41613	**0.02607**	8.46124	**0.02892**
24	36	.31887	**.02084**	.36930	**.02340**	.41690	**.02612**	.46197	**.02897**
28	37	.31974	**.02088**	.37012	**.02345**	.41767	**.02616**	.46270	**.02902**
32	38	.32060	**.02092**	.37093	**.02349**	.41845	**.02621**	.46343	**.02907**
36	39	.32147	**.02096**	.37175	**.02354**	.41921	**.02626**	.46416	**.02912**
40	40	8.32233	**0.02101**	8.37256	**0.02358**	8.41998	**0.02630**	8.46489	**0.02917**
44	41	.32319	**.02105**	.37337	**.02363**	.42075	**.02635**	.46562	**.02922**
48	42	.32405	**.02109**	.37419	**.02367**	.42152	**.02639**	.46634	**.02926**
52	43	.32491	**.02113**	.37500	**.02371**	.42229	**.02644**	.46707	**.02931**
56	44	.32577	**.02117**	.37581	**.02376**	.42305	**.02649**	.46780	**.02936**
s	′	1h 7m	16°	1h 11m	17°	1h 15m	18°	1h 19m	19°
0	45	8.32663	**0.02121**	8.37662	**0.02380**	8.42382	**0.02653**	8.46852	**0.02941**
4	46	.32749	**.02126**	.37742	**.02385**	.42458	**.02658**	.46925	**.02946**
8	47	.32834	**.02130**	.37823	**.02389**	.42535	**.02663**	.46998	**.02951**
12	48	.32920	**.02134**	.37904	**.02394**	.42611	**.02668**	.47070	**.02956**
16	49	.33006	**.02138**	.37985	**.02398**	.42687	**.02672**	.47142	**.02961**
20	50	8.33091	**0.02142**	8.38065	**0.02402**	8.42764	**0.02677**	8.47215	**0.02966**
24	51	.33176	**.02147**	.38146	**.02407**	.42840	**.02682**	.47287	**.02971**
28	52	.33262	**.02151**	.38226	**.02411**	.42916	**.02686**	.47359	**.02976**
32	53	.33347	**.02155**	.38306	**.02416**	.42992	**.02691**	.47431	**.02981**
36	54	.33432	**.02159**	.38387	**.02420**	.43068	**.02696**	.47503	**.02986**
40	55	8.33517	**0.02164**	8.38467	**0.02425**	8.43144	**0.02700**	8.47575	**0.02991**
44	56	.33602	**.02168**	.38547	**.02429**	.43219	**.02705**	.47647	**.02996**
48	57	.33686	**.02172**	.38627	**.02434**	.43295	**.02710**	.47719	**.03000**
52	58	.33771	**.02176**	.38707	**.02438**	.43371	**.02715**	.47791	**.03005**
56	59	.33856	**.02181**	.38787	**.02443**	.43446	**.02719**	.47862	**.03010**
60	60	8.33940	**0.02185**	8.38867	**0.02447**	8.43522	**0.02724**	8.47934	**0.03015**

s	′	$1^h\ 20^m$	20°	$1^h\ 24^m$	21°	$1^h\ 28^m$	22°	$1^h\ 32^m$	23°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	8.47934	**0.03015**	8.52127	**0.03321**	8.56120	**0.03641**	8.59931	**0.03975**
4	**1**	.48006	**.03020**	.52195	**.03326**	.56185	**.03646**	.59993	**.03980**
8	**2**	.48077	**.03025**	.52263	**.03331**	.56250	**.03652**	.60055	**.03986**
12	**3**	.48149	**.03030**	.52331	**.03337**	.56315	**.03657**	.60117	**.03992**
16	**4**	.48220	**.03035**	.52399	**.03342**	.56379	**.03663**	.60179	**.03998**
20	**5**	8.48292	**0.03040**	8.52467	**0.03347**	8.56444	**0.03668**	8.60241	**0.04003**
24	**6**	.48363	**.03045**	.52535	**.03352**	.56509	**.03674**	.60303	**.04009**
28	**7**	.48434	**.03050**	.52602	**.03358**	.56574	**.03679**	.60365	**.04015**
32	**8**	.48505	**.03055**	.52670	**.03363**	.56638	**.03685**	.60426	**.04020**
36	**9**	.48576	**.03060**	.52738	**.03368**	.56703	**.03690**	.60488	**.04026**
40	**10**	8.48648	**0.03065**	8.52806	**0.03373**	8.56767	**0.03695**	8.60550	**0.04032**
44	**11**	.48719	**.03070**	.52873	**.03379**	.56832	**.03701**	.60611	**.04038**
48	**12**	.48789	**.03075**	.52941	**.03384**	.56896	**.03706**	.60673	**.04043**
52	**13**	.48860	**.03080**	.53008	**.03389**	.56960	**.03712**	.60734	**.04049**
56	**14**	.48931	**.03085**	.53076	**.03394**	.57025	**.03717**	.60796	**.04055**
s	′	$1^h\ 21^m$	20°	$1^h\ 25^m$	21°	$1^h\ 29^m$	22°	$1^h\ 33^m$	23°
0	**15**	8.49002	**0.03090**	8.53143	**0.03400**	8.57089	**0.03723**	8.60857	**0.04060**
4	**16**	.49073	**.03095**	.53210	**.03405**	.57153	**.03728**	.60919	**.04066**
8	**17**	.49143	**.03101**	.53277	**.03410**	.57217	**.03734**	.60980	**.04072**
12	**18**	.49214	**.03106**	.53345	**.03415**	.57282	**.03740**	.61041	**.04078**
16	**19**	.49284	**.03111**	.53412	**.03421**	.57346	**.03745**	.61103	**.04083**
20	**20**	8.49355	**0.03116**	8.53479	**0.03426**	8.57410	**0.03751**	8.61164	**0.04089**
24	**21**	.49425	**.03121**	.53546	**.03431**	.57474	**.03756**	.61225	**.04095**
28	**22**	.49496	**.03126**	.53613	**.03437**	.57538	**.03762**	.61286	**.04101**
32	**23**	.49566	**.03131**	.53680	**.03442**	.57601	**.03767**	.61347	**.04106**
36	**24**	.49636	**.03136**	.53747	**.03447**	.57665	**.03773**	.61408	**.04112**
40	**25**	8.49706	**0.03141**	8.53814	**0.03453**	8.57729	**0.03778**	8.61469	**0.04118**
44	**26**	.49777	**.03146**	.53880	**.03458**	.57793	**.03784**	.61530	**.04124**
48	**27**	.49847	**.03151**	.53947	**.03463**	.57856	**.03789**	.61591	**.04130**
52	**28**	.49917	**.03156**	.54014	**.03468**	.57920	**.03795**	.61652	**.04135**
56	**29**	.49987	**.03161**	.54080	**.03474**	.57984	**.03800**	.61713	**.04141**
s	′	$1^h\ 22^m$	20°	$1^h\ 26^m$	21°	$1^h\ 30^m$	22°	$1^h\ 34^m$	23°
0	**30**	8.50056	**0.03166**	8.54147	**0.03479**	8.58047	**0.03806**	8.61773	**0.04147**
4	**31**	.50126	**.03171**	.54214	**.03484**	.58111	**.03812**	.61834	**.04153**
8	**32**	.50196	**.03177**	.54280	**.03490**	.58174	**.03817**	.61895	**.04159**
12	**33**	.50266	**.03182**	.54346	**.03495**	.58238	**.03823**	.61955	**.04164**
16	**34**	.50335	**.03187**	.54413	**.03500**	.58301	**.03828**	.62016	**.04170**
20	**35**	8.50405	**0.03192**	8.54479	**0.03506**	8.58364	**0.03834**	8.62077	**0.04176**
24	**36**	.50475	**.03197**	.54545	**.03511**	.58427	**.03839**	.62137	**.04182**
28	**37**	.50544	**.03202**	.54612	**.03517**	.58491	**.03845**	.62197	**.04188**
32	**38**	.50614	**.03207**	.54678	**.03522**	.58554	**.03851**	.62258	**.04194**
36	**39**	.50683	**.03212**	.54744	**.03527**	.58617	**.03856**	.62318	**.04199**
40	**40**	8.50752	**0.03218**	8.54810	**0.03533**	8.58680	**0.03862**	8.62379	**0.04205**
44	**41**	.50821	**.03223**	.54876	**.03538**	.58743	**.03867**	.62439	**.04211**
48	**42**	.50891	**.03228**	.54942	**.03543**	.58806	**.03873**	.62499	**.04217**
52	**43**	.50960	**.03233**	.55008	**.03549**	.58869	**.03879**	.62559	**.04223**
56	**44**	.51029	**.03238**	.55073	**.03554**	.58932	**.03884**	.62619	**.04229**
s	′	$1^h\ 23^m$	20°	$1^h\ 27^m$	21°	$1^h\ 31^m$	22°	$1^h\ 35^m$	23°
0	**45**	8.51098	**0.03243**	8.55139	**0.03560**	8.58994	**0.03890**	8.62680	**0.04234**
4	**46**	.51167	**.03248**	.55205	**.03565**	.59057	**.03896**	.62740	**.04240**
8	**47**	.51236	**.03254**	.55271	**.03570**	.59120	**.03901**	.62800	**.04246**
12	**48**	.51305	**.03259**	.55336	**.03576**	.59183	**.03907**	.62860	**.04252**
16	**49**	.51374	**.03264**	.55402	**.03581**	.59245	**.03912**	.62919	**.04258**
20	**50**	8.51442	**0.03269**	8.55467	**0.03587**	8.59308	**0.03918**	8.62979	**0.04264**
24	**51**	.51511	**.03274**	.55533	**.03592**	.59370	**.03924**	.63039	**.04270**
28	**52**	.51580	**.03279**	.55598	**.03597**	.59433	**.03929**	.63099	**.04276**
32	**53**	.51648	**.03285**	.55664	**.03603**	.59495	**.03935**	.63159	**.04281**
36	**54**	.51717	**.03290**	.55729	**.03608**	.59558	**.03941**	.63218	**.04287**
40	**55**	8.51785	**0.03295**	8.55794	**0.03614**	8.59620	**0.03946**	8.63278	**0.04293**
44	**56**	.51854	**.03300**	.55859	**.03619**	.59682	**.03952**	.63338	**.04299**
48	**57**	.51922	**.03305**	.55925	**.03624**	.59745	**.03958**	.63397	**.04305**
52	**58**	.51990	**.03311**	.55990	**.03630**	.59807	**.03963**	.63457	**.04311**
56	**59**	.52058	**.03316**	.56055	**.03635**	.59869	**.03969**	.63516	**.04317**
60	**60**	8.52127	**0.03321**	8.56120	**0.03641**	8.59931	**0.03975**	8.63576	**0.04323**

s	′	1h 36m Hav.	24° No.	1h 40m Hav.	25° No.	1h 44m Hav.	26° No.	1h 48m Hav.	27° No.
0	**0**	8.63576	**0.04323**	8.67067	**0.04685**	8.70418	**0.05060**	8.73637	**0.05450**
4	**1**	.63635	**.04329**	.67124	**.04691**	.70472	**.05067**	.73690	**.05456**
8	**2**	.63695	**.04335**	.67181	**.04697**	.70527	**.05073**	.73742	**.05463**
12	**3**	.63754	**.04340**	.67238	**.04703**	.70582	**.05079**	.73795	**.05470**
16	**4**	.63813	**.04346**	.67295	**.04709**	.70636	**.05086**	.73847	**.05476**
20	**5**	8.63872	**0.04352**	8.67352	**0.04715**	8.70691	**0.05092**	8.73900	**0.05483**
24	**6**	.63932	**.04358**	.67409	**.04722**	.70745	**.05099**	.73952	**.05489**
28	**7**	.63991	**.04364**	.67465	**.04728**	.70800	**.05105**	.74005	**.05496**
32	**8**	.64050	**.04370**	.67522	**.04734**	.70854	**.05111**	.74057	**.05503**
36	**9**	.64109	**.04376**	.67579	**.04740**	.70909	**.05118**	.74109	**.05509**
40	**10**	8.64168	**0.04382**	8.67635	**0.04746**	8.70963	**0.05124**	8.74162	**0.05516**
44	**11**	.64227	**.04388**	.67692	**.04752**	.71017	**.05131**	.74214	**.05523**
48	**12**	.64286	**.04394**	.67748	**.04759**	.71072	**.05137**	.74266	**.05529**
52	**13**	.64345	**.04400**	.67805	**.04765**	.71126	**.05144**	.74318	**.05536**
56	**14**	.64404	**.04405**	.67861	**.04771**	.71180	**.05150**	.74371	**.05542**
s	′	1h 37m	24°	1h 41m	25°	1h 45m	26°	1h 49m	27°
0	**15**	8.64463	**0.04412**	8.67918	**0.04777**	8.71234	**0.05156**	8.74423	**0.05549**
4	**16**	.64521	**.04418**	.67974	**.04783**	.71289	**.05163**	.74475	**.05556**
8	**17**	.64580	**.04424**	.68030	**.04790**	.71343	**.05169**	.74527	**.05562**
12	**18**	.64639	**.04430**	.68087	**.04796**	.71397	**.05176**	.74579	**.05569**
16	**19**	.64697	**.04436**	.68143	**.04802**	.71451	**.05182**	.74631	**.05576**
20	**20**	8.64756	**0.04442**	8.68199	**0.04808**	8.71505	**0.05189**	8.74683	**0.05582**
24	**21**	.64815	**.04448**	.68256	**.04815**	.71559	**.05195**	.74735	**.05589**
28	**22**	.64873	**.04454**	.68312	**.04821**	.71613	**.05201**	.74787	**.05596**
32	**23**	.64932	**.04460**	.68368	**.04827**	.71667	**.05208**	.74839	**.05603**
36	**24**	.64990	**.04466**	.68424	**.04833**	.71721	**.05214**	.74890	**.05609**
40	**25**	8.65049	**0.04472**	8.68480	**0.04839**	8.71774	**0.05221**	8.74942	**0.05616**
44	**26**	.65107	**.04478**	.68536	**.04846**	.71828	**.05227**	.74994	**.05623**
48	**27**	.65165	**.04484**	.68592	**.04852**	.71882	**.05234**	.75046	**.05629**
52	**28**	.65224	**.04490**	.68648	**.04858**	.71936	**.05240**	.75097	**.05636**
56	**29**	.65282	**.04496**	.68704	**.04864**	.71989	**.05247**	.75149	**.05643**
s	′	1h 38m	24°	1h 42m	25°	1h 46m	26°	1h 50m	27°
0	**30**	8.65340	**0.04502**	8.68760	**0.04871**	8.72043	**0.05253**	8.75201	**0.05649**
4	**31**	.65398	**.04508**	.68815	**.04877**	.72097	**.05260**	.75252	**.05656**
8	**32**	.65456	**.04514**	.68871	**.04883**	.72150	**.05266**	.75304	**.05663**
12	**33**	.65514	**.04520**	.68927	**.04890**	.72204	**.05273**	.75355	**.05670**
16	**34**	.65572	**.04526**	.68983	**.04896**	.72257	**.05279**	.75407	**.05676**
20	**35**	8.65630	**0.04532**	8.69038	**0.04902**	8.72311	**0.05286**	8.75458	**0.05683**
24	**36**	.65688	**.04538**	.69094	**.04908**	.72364	**.05292**	.75510	**.05690**
28	**37**	.65746	**.04544**	.69149	**.04915**	.72418	**.05299**	.75561	**.05697**
32	**38**	.65804	**.04550**	.69205	**.04921**	.72471	**.05305**	.75613	**.05703**
36	**39**	.65862	**.04556**	.69260	**.04927**	.72525	**.05312**	.75664	**.05710**
40	**40**	8.65920	**0.04562**	8.69316	**0.04934**	8.72578	**0.05318**	8.75715	**0.05717**
44	**41**	.65978	**.04569**	.69371	**.04940**	.72631	**.05325**	.75767	**.05724**
48	**42**	.66035	**.04575**	.69427	**.04946**	.72684	**.05331**	.75818	**.05730**
52	**43**	.66093	**.04581**	.69482	**.04952**	.72738	**.05338**	.75869	**.05737**
56	**44**	.66151	**.04587**	.69537	**.04959**	.72791	**.05345**	.75920	**.05744**
s	′	1h 39m	24°	1h 43m	25°	1h 47m	26°	1h 51m	27°
0	**45**	8.66208	**0.04593**	8.69593	**0.04965**	8.72844	**0.05351**	8.75972	**0.05751**
4	**46**	.66266	**.04599**	.69648	**.04971**	.72897	**.05358**	.76023	**.05757**
8	**47**	.66323	**.04605**	.69703	**.04978**	.72950	**.05364**	.76074	**.05764**
12	**48**	.66381	**.04611**	.69758	**.04984**	.73003	**.05371**	.76125	**.05771**
16	**49**	.66438	**.04617**	.69814	**.04990**	.73056	**.05377**	.76176	**.05778**
20	**50**	8.66496	**0.04623**	8.69869	**0.04997**	8.73109	**0.05384**	8.76227	**0.05785**
24	**51**	.66553	**.04629**	.69924	**.05003**	.73162	**.05390**	.76278	**.05791**
28	**52**	.66610	**.04636**	.69979	**.05009**	.73215	**.05397**	.76329	**.05798**
32	**53**	.66668	**.04642**	.70034	**.05016**	.73268	**.05404**	.76380	**.05805**
36	**54**	.66725	**.04648**	.70089	**.05022**	.73321	**.05410**	.76431	**.05812**
40	**55**	8.66782	**0.04654**	8.70144	**0.05028**	8.73374	**0.05417**	8.76481	**0.05819**
44	**56**	.66839	**.04660**	.70198	**.05035**	.73426	**.05423**	.76532	**.05825**
48	**57**	.66896	**.04666**	.70253	**.05041**	.73479	**.05430**	.76583	**.05832**
52	**58**	.66953	**.04672**	.70308	**.05048**	.73532	**.05436**	.76634	**.05839**
56	**59**	.67010	**.04678**	.70363	**.05054**	.73584	**.05443**	.76684	**.05846**
60	**60**	8.67067	**0.04685**	8.70418	**0.05060**	8.73637	**0.05450**	8.76735	**0.05853**

s	′	$1^h\ 52^m$	28°	$1^h\ 56^m$	29°	$2^h\ 0^m$	30°	$2^h\ 4^m$	31°
		Hav.	No.	Hav.	No.	Hav.	No.	Hav.	No.
0	0	8.76735	0.05853	8.79720	0.06269	8.82599	0.06699	8.85380	0.07142
4	1	.76786	.05859	.79769	.06276	.82646	.06706	.85425	.07149
8	2	.76836	.05866	.79818	.06283	.82694	.06713	.85471	.07157
12	3	.76887	.05873	.79866	.06290	.82741	.06721	.85516	.07164
16	4	.76938	.05880	.79915	.06297	.82788	.06728	.85562	.07172
20	5	8.76988	0.05887	8.79964	0.06304	8.82835	0.06735	8.85607	0.07179
24	6	.77039	.05894	.80013	.06311	.82882	.06742	.85653	.07187
28	7	.77089	.05901	.80061	.06318	.82929	.06750	.85698	.07194
32	8	.77139	.05907	.80110	.06326	.82976	.06757	.85743	.07202
36	9	.77190	.05914	.80158	.06333	.83023	.06764	.85789	.07209
40	10	8.77240	0.05921	8.80207	0.06340	8.83069	0.06772	8.85834	0.07217
44	11	.77291	.05928	.80256	.06347	.83116	.06779	.85879	.07224
48	12	.77341	.05935	.80304	.06354	.83163	.06786	.85925	.07232
52	13	.77391	.05942	.80353	.06361	.83210	.06794	.85970	.07239
56	14	.77441	.05949	.80401	.06368	.83257	.06801	.86015	.07247
s	′	$1^h\ 53^m$	28°	$1^h\ 57^m$	29°	$2^h\ 1^m$	30°	$2^h\ 5^m$	31°
0	15	8.77492	0.05955	8.80449	0.06375	8.83303	0.06808	8.86060	0.07254
4	16	.77542	.05962	.80498	.06382	.83350	.06816	.86105	.07262
8	17	.77592	.05969	.80546	.06389	.83397	.06823	.86151	.07270
12	18	.77642	.05976	.80595	.06397	.83444	.06830	.86196	.07277
16	19	.77692	.05983	.80643	.06404	.83490	.06838	.86241	.07285
20	20	8.77742	0.05990	8.80691	0.06411	8.83537	0.06845	8.86286	0.07292
24	21	.77792	.05997	.80739	.06418	.83583	.06852	.86331	.07300
28	22	.77842	.06004	.80788	.06425	.83630	.06860	.86376	.07307
32	23	.77892	.06011	.80836	.06432	.83676	.06867	.86421	.07315
36	24	.77942	.06018	.80884	.06439	.83723	.06874	.86466	.07322
40	25	8.77992	0.06024	8.80932	0.06446	8.83769	0.06882	8.86511	0.07330
44	26	.78042	.06031	.80980	.06454	.83816	.06889	.86556	.07338
48	27	.78092	.06038	.81028	.06461	.83862	.06896	.86600	.07345
52	28	.78142	.06045	.81076	.06468	.83909	.06904	.86645	.07353
56	29	.78191	.06052	.81124	.06475	.83955	.06911	.86690	.07360
s	′	$1^h\ 54^m$	28°	$1^h\ 58^m$	29°	$2^h\ 2^m$	30°	$2^h\ 6^m$	31°
0	30	8.78241	0.06059	8.81172	0.06482	8.84002	0.06919	8.86735	0.07368
4	31	.78291	.06066	.81220	.06489	.84048	.06926	.86780	.07376
8	32	.78341	.06073	.81268	.06497	.84094	.06933	.86825	.07383
12	33	.78390	.06080	.81316	.06504	.84140	.06941	.86869	.07391
16	34	.78440	.06087	.81364	.06511	.84187	.06948	.86914	.07398
20	35	8.78490	0.06094	8.81412	0.06518	8.84233	0.06956	8.86959	0.07406
24	36	.78539	.06101	.81460	.06525	.84279	.06963	.87003	.07414
28	37	.78589	.06108	.81508	.06532	.84325	.06970	.87048	.07421
32	38	.78638	.06115	.81555	.06540	.84371	.06978	.87093	.07429
36	39	.78688	.06122	.81603	.06547	.84417	.06985	.87137	.07437
40	40	8.78737	0.06129	8.81651	0.06554	8.84464	0.06993	8.87182	0.07444
44	41	.78787	.06136	.81699	.06561	.84510	.07000	.87226	.07452
48	42	.78836	.06143	.81746	.06568	.84556	.07007	.87271	.07459
52	43	.78885	.06150	.81794	.06576	.84602	.07015	.87315	.07467
56	44	.78935	.06157	.81841	.06583	.84648	.07022	.87360	.07475
s	′	$1^h\ 55^m$	28°	$1^h\ 59^m$	29°	$2^h\ 3^m$	30°	$2^h\ 7^m$	31°
0	45	8.78984	0.06164	8.81889	0.06590	8.84694	0.07030	8.87404	0.07482
4	46	.79033	.06171	.81937	.06597	.84740	.07037	.87448	.07490
8	47	.79082	.06178	.81984	.06605	.84785	.07045	.87493	.07498
12	48	.79132	.06185	.82032	.06612	.84831	.07052	.87537	.07505
16	49	.79181	.06192	.82079	.06619	.84877	.07059	.87582	.07513
20	50	8.79230	0.06199	8.82126	0.06626	8.84923	0.07067	8.87626	0.07521
24	51	.79279	.06206	.82174	.06633	.84969	.07074	.87670	.07528
28	52	.79328	.06213	.82221	.06641	.85015	.07082	.87714	.07536
32	53	.79377	.06220	.82269	.06648	.85060	.07089	.87759	.07544
36	54	.79426	.06227	.82316	.06655	.85106	.07097	.87803	.07551
40	55	8.79475	0.06234	8.82363	0.06662	8.85152	0.07104	8.87847	0.07559
44	56	.79524	.06241	.82410	.06670	.85197	.07112	.87891	.07567
48	57	.79573	.06248	.82458	.06677	.85243	.07119	.87935	.07574
52	58	.79622	.06255	.82505	.06684	.85289	.07127	.87980	.07582
56	59	.79671	.06262	.82552	.06691	.85334	.07134	.88024	.07590
60	60	8.79720	0.06269	8.82599	0.06699	8.85380	0.07142	8.88068	0.07598

s	′	$2^h\ 8^m$ Hav.	32° No.	$2^h\ 12^m$ Hav.	33° No.	$2^h\ 16^m$ Hav.	34° No.	$2^h\ 20^m$ Hav.	35° No.
0	0	8.88068	0.07598	8.90668	0.08066	8.93187	0.08548	8.95628	0.09042
4	1	.88112	.07605	.90711	.08074	.93228	.08556	.95668	.09051
8	2	.88156	.07613	.90754	.08082	.93270	.08564	.95709	.09059
12	3	.88200	.07621	.90796	.08090	.93311	.08573	.95749	.09067
16	4	.88244	.07628	.90839	.08098	.93352	.08581	.95789	.09076
20	5	8.88288	0.07636	8.90881	0.08106	8.93393	0.08589	8.95828	0.09084
24	6	.88332	.07644	.90924	.08114	.93435	.08597	.95868	.09093
28	7	.88375	.07652	.90966	.08122	.93476	.08605	.95908	.09101
32	8	.88419	.07659	.91009	.08130	.93517	.08613	.95948	.09109
36	9	.88463	.07667	.91051	.08138	.93558	.08621	.95988	.09118
40	10	8.88507	0.07675	8.91094	0.08146	8.93599	0.08630	8.96028	0.09126
44	11	.88551	.07683	.91136	.08154	.93640	.08638	.96068	.09134
48	12	.88595	.07690	.91179	.08162	.93681	.08646	.96108	.09143
52	13	.88638	.07698	.91221	.08170	.93722	.08654	.96148	.09151
56	14	.88682	.07706	.91263	.08178	.93764	.08662	.96187	.09160
s	′	$2^h\ 9^m$	32°	$2^h\ 13^m$	33°	$2^h\ 17^m$	34°	$2^h\ 21^m$	35°
0	15	8.88726	0.07714	8.91306	0.08186	8.93805	0.08671	8.96227	0.09168
4	16	.88769	.07721	.91348	.08194	.93846	.08679	.96267	.09176
8	17	.88813	.07729	.91390	.08202	.93886	.08687	.96307	.09185
12	18	.88857	.07737	.91432	.08210	.93927	.08695	.96346	.09193
16	19	.88900	.07745	.91475	.08218	.93968	.08703	.96386	.09202
20	20	8.88944	0.07752	8.91517	0.08226	8.94009	0.08711	8.96426	0.09210
24	21	.88988	.07760	.91559	.08234	.94050	.08720	.96465	.09218
28	22	.89031	.07768	.91601	.08242	.94091	.08728	.96505	.09227
32	23	.89075	.07776	.91643	.08250	.94132	.08736	.96545	.09235
36	24	.89118	.07784	.91685	.08258	.94173	.08744	.96584	.09244
40	25	8.89162	0.07791	8.91728	0.08266	8.94213	0.08753	8.96624	0.09252
44	26	.89205	.07799	.91770	.08274	.94254	.08761	.96663	.09260
48	27	.89248	.07807	.91812	.08282	.94295	.08769	.96703	.09269
52	28	.89292	.07815	.91854	.08290	.94336	.08777	.96742	.09277
56	29	.89335	.07823	.91896	.08298	.94376	.08785	.96782	.09286
s	′	$2^h\ 10^m$	32°	$2^h\ 14^m$	33°	$2^h\ 18^m$	34°	$2^h\ 22^m$	35°
0	30	8.89379	0.07830	8.91938	0.08306	8.94417	0.08794	8.96821	0.09294
4	31	.89422	.07838	.91980	.08314	.94458	.08802	.96861	.09303
8	32	.89465	.07846	.92022	.08322	.94498	.08810	.96900	.09311
12	33	.89509	.07854	.92064	.08330	.94539	.08818	.96940	.09320
16	34	.89552	.07862	.92105	.08338	.94580	.08827	.96979	.09328
20	35	8.89595	0.07870	8.92147	0.08346	8.94620	0.08835	8.97018	0.09337
24	36	.89638	.07877	.92189	.08354	.94661	.08843	.97058	.09345
28	37	.89681	.07885	.92231	.08362	.94701	.08851	.97097	.09353
32	38	.89725	.07893	.92273	.08370	.94742	.08860	.97136	.09362
36	39	.89768	.07901	.92315	.08378	.94782	.08868	.97176	.09370
40	40	8.89811	0.07909	8.92356	0.08386	8.94823	0.08876	8.97215	0.09379
44	41	.89854	.07917	.92398	.08394	.94863	.08885	.97254	.09387
48	42	.89897	.07924	.92440	.08402	.94904	.08893	.97294	.09396
52	43	.89940	.07932	.92482	.08410	.94944	.08901	.97333	.09404
56	44	.89983	.07940	.92523	.08418	.94985	.08909	.97372	.09413
s	′	$2^h\ 11^m$	32°	$2^h\ 15^m$	33°	$2^h\ 19^m$	34°	$2^h\ 23^m$	35°
0	45	8.90026	0.07948	8.92565	0.08427	8.95025	0.08918	8.97411	0.09421
4	46	.90069	.07956	.92607	.08435	.95065	.08926	.97450	.09430
8	47	.90112	.07964	.92648	.08443	.95106	.08934	.97489	.09438
12	48	.90155	.07972	.92690	.08451	.95146	.08943	.97529	.09447
16	49	.90198	.07980	.92731	.08459	.95186	.08951	.97568	.09455
20	50	8.90241	0.07987	8.92773	0.08467	8.95227	0.08959	8.97607	0.09464
24	51	.90284	.07995	.92814	.08475	.95267	.08967	.97646	.09472
28	52	.90326	.08003	.92856	.08483	.95307	.08976	.97685	.09481
32	53	.90369	.08011	.92897	.08491	.95347	.08984	.97724	.09489
36	54	.90412	.08019	.92939	.08499	.95388	.08992	.97763	.09498
40	55	8.90455	0.08027	8.92980	0.08508	8.95428	0.09001	8.97802	0.09506
44	56	.90498	.08035	.93022	.08516	.95468	.09009	.97841	.09515
48	57	.90540	.08043	.93063	.08524	.95508	.09017	.97880	.09524
52	58	.90583	.08051	.93104	.08532	.95548	.09026	.97919	.09532
56	59	.90626	.08059	.93146	.08540	.95588	.09034	.97958	.09541
60	60	8.90668	0.08066	8.93187	0.08548	8.95628	0.09042	8.97997	0.09549

s	′	2h 24m	36°	2h 28m	37°	2h 32m	38°	2h 36m	39°
		Hav.	No.	Hav.	No.	Hav.	No.	Hav.	No.
0	0	8.97997	0.09549	9.00295	0.10068	9.02528	0.10599	9.04699	0.11143
4	1	.98035	.09558	.00333	.10077	.02565	.10608	.04735	.11152
8	2	.98074	.09566	.00371	.10086	.02602	.10617	.04770	.11161
12	3	.98113	.09575	.00408	.10095	.02638	.10626	.04806	.11170
16	4	.98152	.09583	.00446	.10103	.02675	.10635	.04842	.11179
20	5	8.98191	0.09592	9.00484	0.10112	9.02712	0.10644	9.04877	0.11189
24	6	.98229	.09601	.00522	.10121	.02748	.10653	.04913	.11198
28	7	.98268	.09609	.00559	.10130	.02785	.10662	.04948	.11207
32	8	.98307	.09618	.00597	.10138	.02821	.10671	.04984	.11216
36	9	.98346	.09626	.00634	.10147	.02858	.10680	.05019	.11225
40	10	8.98384	0.09635	9.00672	0.10156	9.02894	0.10689	9.05055	0.11234
44	11	.98423	.09643	.00710	.10165	.02931	.10698	.05090	.11244
48	12	.98462	.09652	.00747	.10174	.02967	.10707	.05126	.11253
52	13	.98500	.09661	.00785	.10182	.03004	.10716	.05161	.11262
56	14	.98539	.09669	.00822	.10191	.03040	.10725	.05197	.11271
s	′	2h 25m	36°	2h 29m	37°	2h 33m	38°	2h 37m	39°
0	15	8.98578	0.09678	9.00860	0.10200	9.03077	0.10734	9.05232	0.11280
4	16	.98616	.09686	.00897	.10209	.03113	.10743	.05268	.11290
8	17	.98655	.09695	.00935	.10218	.03150	.10752	.05303	.11299
12	18	.98693	.09704	.00972	.10226	.03186	.10761	.05339	.11308
16	19	.98732	.09712	.01009	.10235	.03222	.10770	.05374	.11317
20	20	8.98770	0.09721	9.01047	0.10244	9.03259	0.10779	9.05409	0.11326
24	21	.98809	.09729	.01084	.10253	.03295	.10788	.05445	.11336
28	22	.98847	.09738	.01122	.10262	.03331	.10797	.05480	.11345
32	23	.98886	.09747	.01159	.10270	.03368	.10806	.05515	.11354
36	24	.98924	.09755	.01196	.10279	.03404	.10815	.05551	.11363
40	25	8.98963	0.09764	9.01234	0.10288	9.03440	0.10824	9.05586	0.11373
44	26	.99001	.09773	.01271	.10297	.03476	.10833	.05621	.11382
48	27	.99039	.09781	.01308	.10306	.03513	.10842	.05656	.11391
52	28	.99078	.09790	.01345	.10315	.03549	.10851	.05692	.11400
56	29	.99116	.09799	.01383	.10323	.03585	.10861	.05727	.11410
s	′	2h 26m	36°	2h 30m	37°	2h 34m	38°	2h 38m	39°
0	30	8.99154	0.09807	9.01420	0.10332	9.03621	0.10870	9.05762	0.11419
4	31	.99193	.09816	.01457	.10341	.03657	.10879	.05797	.11428
8	32	.99231	.09824	.01494	.10350	.03694	.10888	.05832	.11437
12	33	.99269	.09833	.01531	.10359	.03730	.10897	.05867	.11447
16	34	.99307	.09842	.01569	.10368	.03766	.10906	.05903	.11456
20	35	8.99346	0.09850	9.01606	0.10377	9.03802	0.10915	9.05938	0.11465
24	36	.99384	.09859	.01643	.10386	.03838	.10924	.05973	.11474
28	37	.99422	.09868	.01680	.10394	.03874	.10933	.06008	.11484
32	38	.99460	.09876	.01717	.10403	.03910	.10942	.06043	.11493
36	39	.99498	.09885	.01754	.10412	.03946	.10951	.06078	.11502
40	40	8.99536	0.09894	9.01791	0.10421	9.03982	0.10960	9.06113	0.11511
44	41	.99575	.09903	.01828	.10430	.04018	.10969	.06148	.11521
48	42	.99613	.09911	.01865	.10439	.04054	.10978	.06183	.11530
52	43	.99651	.09920	.01902	.10448	.04090	.10988	.06218	.11539
56	44	.99689	.09929	.01939	.10457	.04126	.10997	.06253	.11549
s	′	2h 27m	36°	2h 31m	37°	2h 35m	38°	2h 39m	39°
0	45	8.99727	0.09937	9.01976	0.10466	9.04162	0.11006	9.06288	0.11558
4	46	.99765	.09946	.02013	.10474	.04198	.11015	.06323	.11567
8	47	.99803	.09955	.02050	.10483	.04234	.11024	.06358	.11577
12	48	.99841	.09963	.02087	.10492	.04270	.11033	.06393	.11586
16	49	.99879	.09972	.02124	.10501	.04306	.11042	.06428	.11595
20	50	8.99917	0.09981	9.02161	0.10510	9.04341	0.11051	9.06462	0.11604
24	51	.99955	.09990	.02197	.10519	.04377	.11060	.06497	.11614
28	52	.99993	.09998	.02234	.10528	.04413	.11070	.06532	.11623
32	53	9.00031	.10007	.02271	.10537	.04449	.11079	.06567	.11632
36	54	.00068	.10016	.02308	.10546	.04485	.11088	.06602	.11642
40	55	9.00106	0.10025	9.02345	0.10555	9.04520	0.11097	9.06637	0.11651
44	56	.00144	.10033	.02381	.10564	.04556	.11106	.06671	.11660
48	57	.00182	.10042	.02418	.10573	.04592	.11115	.06706	.11670
52	58	.00220	.10051	.02455	.10582	.04628	.11124	.06741	.11679
56	59	.00258	.10059	.02492	.10591	.04663	.11134	.06776	.11688
60	60	9.00295	0.10068	9.02528	0.10599	9.04699	0.11143	9.06810	0.11698

s	′	$2^h\,40^m$ Hav.	40° No.	$2^h\,44^m$ Hav.	41° No.	$2^h\,48^m$ Hav.	42° No.	$2^h\,52^m$ Hav.	43° No.
0	**0**	9.06810	**0.11698**	9.08865	**0.12265**	9.10866	**0.12843**	9.12815	**0.13432**
4	**1**	.06845	**.11707**	.08899	**.12274**	.10899	**.12852**	.12847	**.13442**
8	**2**	.06880	**.11716**	.08933	**.12284**	.10932	**.12862**	.12879	**.13452**
12	**3**	.06914	**.11726**	.08966	**.12293**	.10965	**.12872**	.12911	**.13462**
16	**4**	.06949	**.11735**	.09000	**.12303**	.10997	**.12882**	.12943	**.13472**
20	**5**	9.06984	**0.11745**	9.09034	**0.12312**	9.11030	**0.12891**	9.12975	**0.13482**
24	**6**	.07018	**.11754**	.09068	**.12322**	.11063	**.12901**	.13007	**.13492**
28	**7**	.07053	**.11763**	.09101	**.12331**	.11096	**.12911**	.13039	**.13502**
32	**8**	.07088	**.11773**	.09135	**.12341**	.11129	**.12921**	.13071	**.13512**
36	**9**	.07122	**.11782**	.09169	**.12351**	.11161	**.12930**	.13103	**.13522**
40	**10**	9.07157	**0.11791**	9.09202	**0.12360**	9.11194	**0.12940**	9.13135	**0.13532**
44	**11**	.07191	**.11801**	.09236	**.12370**	.11227	**.12950**	.13167	**.13542**
48	**12**	.07226	**.11810**	.09269	**.12379**	.11260	**.12960**	.13199	**.13552**
52	**13**	.07260	**.11820**	.09303	**.12389**	.11292	**.12970**	.13231	**.13562**
56	**14**	.07295	**.11829**	.09337	**.12398**	.11325	**.12979**	.13263	**.13571**
s	′	$2^h\,41^m$	40°	$2^h\,45^m$	41°	$2^h\,49^m$	42°	$2^h\,53^m$	43°
0	**15**	9.07329	**0.11838**	9.09370	**0.12408**	9.11358	**0.12989**	9.13295	**0.13581**
4	**16**	.07364	**.11848**	.09404	**.12418**	.11391	**.12999**	.13326	**.13591**
8	**17**	.07398	**.11857**	.09437	**.12427**	.11423	**.13009**	.13358	**.13601**
12	**18**	.07433	**.11867**	.09471	**.12437**	.11456	**.13018**	.13390	**.13611**
16	**19**	.07467	**.11876**	.09504	**.12446**	.11489	**.13028**	.13422	**.13621**
20	**20**	9.07501	**0.11885**	9.09538	**0.12456**	9.11521	**0.13038**	9.13454	**0.13631**
24	**21**	.07536	**.11895**	.09571	**.12466**	.11554	**.13048**	.13486	**.13641**
28	**22**	.07570	**.11904**	.09605	**.12475**	.11586	**.13058**	.13517	**.13651**
32	**23**	.07605	**.11914**	.09638	**.12485**	.11619	**.13067**	.13549	**.13661**
36	**24**	.07639	**.11923**	.09672	**.12494**	.11652	**.13077**	.13581	**.13671**
40	**25**	9.07673	**0.11933**	9.09705	**0.12504**	9.11684	**0.13087**	9.13613	**0.13681**
44	**26**	.07708	**.11942**	.09739	**.12514**	.11717	**.13097**	.13644	**.13691**
48	**27**	.07742	**.11951**	.09772	**.12523**	.11749	**.13107**	.13676	**.13701**
52	**28**	.07776	**.11961**	.09805	**.12533**	.11782	**.13116**	.13708	**.13711**
56	**29**	.07810	**.11970**	.09839	**.12543**	.11814	**.13126**	.13739	**.13721**
s	′	$2^h\,42^m$	40°	$2^h\,46^m$	41°	$2^h\,50^m$	42°	$2^h\,54^m$	43°
0	**30**	9.07845	**0.11980**	9.09872	**0.12552**	9.11847	**0.13136**	9.13771	**0.13731**
4	**31**	.07879	**.11989**	.09905	**.12562**	.11879	**.13146**	.13803	**.13741**
8	**32**	.07913	**.11999**	.09939	**.12572**	.11912	**.13156**	.13834	**.13751**
12	**33**	.07947	**.12008**	.09972	**.12581**	.11944	**.13166**	.13866	**.13761**
16	**34**	.07981	**.12018**	.10005	**.12591**	.11977	**.13175**	.13898	**.13771**
20	**35**	9.08016	**0.12027**	9.10039	**0.12600**	9.12009	**0.13185**	9.13929	**0.13781**
24	**36**	.08050	**.12036**	.10072	**.12610**	.12041	**.13195**	.13961	**.13791**
28	**37**	.08084	**.12046**	.10105	**.12620**	.12074	**.13205**	.13992	**.13801**
32	**38**	.08118	**.12055**	.10138	**.12629**	.12106	**.13215**	.14024	**.13811**
36	**39**	.08152	**.12065**	.10172	**.12639**	.12139	**.13225**	.14056	**.13822**
40	**40**	9.08186	**0.12074**	9.10205	**0.12649**	9.12171	**0.13235**	9.14087	**0.13832**
44	**41**	.08220	**.12084**	.10238	**.12658**	.12203	**.13244**	.14119	**.13842**
48	**42**	.08254	**.12093**	.10271	**.12668**	.12236	**.13254**	.14150	**.13852**
52	**43**	.08288	**.12103**	.10304	**.12678**	.12268	**.13264**	.14182	**.13862**
56	**44**	.08323	**.12112**	.10337	**.12687**	.12300	**.13274**	.14213	**.13872**
s	′	$2^h\,43^m$	40°	$2^h\,47^m$	41°	$2^h\,51^m$	42°	$2^h\,55^m$	43°
0	**45**	9.08357	**0.12122**	9.10371	**0.12697**	9.12332	**0.13284**	9.14245	**0.13882**
4	**46**	.08391	**.12131**	.10404	**.12707**	.12365	**.13294**	.14276	**.13892**
8	**47**	.08425	**.12141**	.10437	**.12717**	.12397	**.13304**	.14307	**.13902**
12	**48**	.08459	**.12150**	.10470	**.12726**	.12429	**.13314**	.14339	**.13912**
16	**49**	.08492	**.12160**	.10503	**.12736**	.12461	**.13323**	.14370	**.13922**
20	**50**	9.08526	**0.12169**	9.10536	**0.12746**	9.12494	**0.13333**	9.14402	**0.13932**
24	**51**	.08560	**.12179**	.10569	**.12755**	.12526	**.13343**	.14433	**.13942**
28	**52**	.08594	**.12188**	.10602	**.12765**	.12558	**.13353**	.14465	**.13952**
32	**53**	.08628	**.12198**	.10635	**.12775**	.12590	**.13363**	.14496	**.13962**
36	**54**	.08662	**.12207**	.10668	**.12784**	.12622	**.13373**	.14527	**.13972**
40	**55**	9.08696	**0.12217**	9.10701	**0.12794**	9.12655	**0.13383**	9.14559	**0.13983**
44	**56**	.08730	**.12226**	.10734	**.12804**	.12687	**.13393**	.14590	**.13993**
48	**57**	.08764	**.12236**	.10767	**.12814**	.12719	**.13403**	.14621	**.14003**
52	**58**	.08797	**.12245**	.10800	**.12823**	.12751	**.13412**	.14653	**.14013**
56	**59**	.08831	**.12255**	.10833	**.12833**	.12783	**.13422**	.14684	**.14023**
60	**60**	9.08865	**0.12265**	9.10866	**0.12843**	9.12815	**0.13432**	9.14715	**0.14033**

s	′	$2^h\ 56^m$	44°	$3^h\ 0^m$	45°	$3^h\ 4^m$	46°	$3^h\ 8^m$	47°
		Hav.	No.	Hav.	No.	Hav.	No.	Hav.	No.
0	0	9.14715	0.14033	9.16568	0.14645	9.18376	0.15267	9.20140	0.15900
4	1	.14746	.14043	.16598	.14655	.18405	.15278	.20169	.15911
8	2	.14778	.14053	.16629	.14665	.18435	.15288	.20198	.15921
12	3	.14809	.14063	.16659	.14676	.18465	.15298	.20227	.15932
16	4	.14840	.14073	.16690	.14686	.18495	.15309	.20256	.15943
20	5	9.14871	0.14084	9.16720	0.14696	9.18524	0.15319	9.20285	0.15953
24	6	.14902	.14094	.16751	.14706	.18554	.15330	.20314	.15964
28	7	.14934	.14104	.16781	.14717	.18584	.15340	.20343	.15975
32	8	.14965	.14114	.16812	.14727	.18613	.15351	.20372	.15985
36	9	.14996	.14124	.16842	.14737	.18643	.15361	.20401	.15996
40	10	9.15027	0.14134	9.16872	0.14748	9.18673	0.15372	9.20430	0.16007
44	11	.15058	.14144	.16903	.14758	.18702	.15382	.20459	.16017
48	12	.15089	.14154	.16933	.14768	.18732	.15393	.20488	.16028
52	13	.15120	.14165	.16963	.14779	.18762	.15403	.20517	.16039
56	14	.15152	.14175	.16994	.14789	.18791	.15414	.20546	.16049
s	′	$2^h\ 57^m$	44°	$3^h\ 1^m$	45°	$3^h\ 5^m$	46°	$3^h\ 9^m$	47°
0	15	9.15183	0.14185	9.17024	0.14799	9.18821	0.15424	9.20574	0.16060
4	16	.15214	.14195	.17054	.14810	.18850	.15435	.20603	.16071
8	17	.15245	.14205	.17085	.14820	.18880	.15445	.20632	.16081
12	18	.15276	.14215	.17115	.14830	.18909	.15456	.20661	.16092
16	19	.15307	.14226	.17145	.14841	.18939	.15466	.20690	.16103
20	20	9.15338	0.14236	9.17175	0.14851	9.18968	0.15477	9.20719	0.16113
24	21	.15369	.14246	.17206	.14861	.18998	.15487	.20748	.16124
28	22	.15400	.14256	.17236	.14872	.19027	.15498	.20776	.16135
32	23	.15431	.14266	.17266	.14882	.19057	.15509	.20805	.16146
36	24	.15462	.14276	.17296	.14892	.19086	.15519	.20834	.16156
40	25	9.15493	0.14287	9.17327	0.14903	9.19116	0.15530	9.20863	0.16167
44	26	.15524	.14297	.17357	.14913	.19145	.15540	.20891	.16178
48	27	.15555	.14307	.17387	.14923	.19175	.15551	.20920	.16188
52	28	.15585	.14317	.17417	.14934	.19204	.15561	.20949	.16199
56	29	.15616	.14327	.17447	.14944	.19234	.15572	.20978	.16210
s	′	$2^h\ 58^m$	44°	$3^h\ 2^m$	45°	$3^h\ 6^m$	46°	$3^h\ 10^m$	47°
0	30	9.15647	0.14337	9.17477	0.14955	9.19263	0.15582	9.21006	0.16220
4	31	.15678	.14348	.17507	.14965	.19292	.15593	.21035	.16231
8	32	.15709	.14358	.17538	.14975	.19322	.15603	.21064	.16242
12	33	.15740	.14368	.17568	.14986	.19351	.15614	.21092	.16253
16	34	.15771	.14378	.17598	.14996	.19381	.15625	.21121	.16263
20	35	9.15802	0.14388	9.17628	0.15006	9.19410	0.15635	9.21150	0.16274
24	36	.15832	.14399	.17658	.15017	.19439	.15646	.21178	.16285
28	37	.15863	.14409	.17688	.15027	.19469	.15656	.21207	.16296
32	38	.15894	.14419	.17718	.15038	.19498	.15667	.21236	.16306
36	39	.15925	.14429	.17748	.15048	.19527	.15677	.21264	.16317
40	40	9.15955	0.14440	9.17778	0.15058	9.19557	0.15688	9.21293	0.16328
44	41	.15986	.14450	.17808	.15069	.19586	.15699	.21322	.16339
48	42	.16017	.14460	.17838	.15079	.19615	.15709	.21350	.16349
52	43	.16048	.14470	.17868	.15090	.19644	.15720	.21379	.16360
56	44	.16078	.14480	.17898	.15100	.19674	.15730	.21407	.16371
s	′	$2^h\ 59^m$	44°	$3^h\ 3^m$	45°	$3^h\ 7^m$	46°	$3^h\ 11^m$	47°
0	45	9.16109	0.14491	9.17928	0.15110	9.19703	0.15741	9.21436	0.16382
4	46	.16140	.14501	.17958	.15121	.19732	.15751	.21464	.16392
8	47	.16170	.14511	.17988	.15131	.19761	.15762	.21493	.16403
12	48	.16201	.14521	.18018	.15142	.19790	.15773	.21521	.16414
16	49	.16232	.14532	.18048	.15152	.19820	.15783	.21550	.16425
20	50	9.16262	0.14542	9.18077	0.15163	9.19849	0.15794	9.21578	0.16436
24	51	.16293	.14552	.18107	.15173	.19878	.15804	.21607	.16446
28	52	.16324	.14562	.18137	.15183	.19907	.15815	.21635	.16457
32	53	.16354	.14573	.18167	.15194	.19936	.15826	.21664	.16468
36	54	.16385	.14583	.18197	.15204	.19965	.15836	.21692	.16479
40	55	9.16415	0.14593	9.18227	0.15215	9.19995	0.15847	9.21721	0.16489
44	56	.16446	.14604	.18256	.15225	.20024	.15858	.21749	.16500
48	57	.16476	.14614	.18286	.15236	.20053	.15868	.21778	.16511
52	58	.16507	.14624	.18316	.15246	.20082	.15879	.21806	.16522
56	59	.16537	.14634	.18346	.15257	.20111	.15889	.21834	.16533
60	60	9.16568	0.14645	9.18376	0.15267	9.20140	0.15900	9.21863	0.16543

s	′	$3^h\ 12^m$	48°	$3^h\ 16^m$	49°	$3^h\ 20^m$	50°	$3^h\ 24^m$	51°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	9.21863	**0.16543**	9.23545	**0.17197**	9.25190	**0.17861**	9.26797	**0.18534**
4	**1**	.21891	**.16554**	.23573	**.17208**	.25217	**.17872**	.26823	**.18545**
8	**2**	.21919	**.16565**	.23601	**.17219**	.25244	**.17883**	.26850	**.18557**
12	**3**	.21948	**.16576**	.23629	**.17230**	.25271	**.17894**	.26876	**.18568**
16	**4**	.21976	**.16587**	.23656	**.17241**	.25298	**.17905**	.26903	**.18579**
20	**5**	9.22004	**0.16598**	9.23684	**0.17252**	9.25325	**0.17916**	9.26929	**0.18591**
24	**6**	.22033	**.16608**	.23712	**.17263**	.25352	**.17928**	.26956	**.18602**
28	**7**	.22061	**.16619**	.23739	**.17274**	.25379	**.17939**	.26982	**.18613**
32	**8**	.22089	**.16630**	.23767	**.17285**	.25406	**.17950**	.27008	**.18624**
36	**9**	.22118	**.16641**	.23794	**.17296**	.25433	**.17961**	.27035	**.18636**
40	**10**	9.22146	**0.16652**	9.23822	**0.17307**	9.25460	**0.17972**	9.27061	**0.18647**
44	**11**	.22174	**.16663**	.23850	**.17318**	.25487	**.17983**	.27088	**.18658**
48	**12**	.22202	**.16673**	.23877	**.17329**	.25514	**.17995**	.27114	**.18670**
52	**13**	.22231	**.16684**	.23905	**.17340**	.25541	**.18006**	.27140	**.18681**
56	**14**	.22259	**.16695**	.23932	**.17351**	.25568	**.18017**	.27167	**.18692**
s	′	$3^h\ 13^m$	48°	$3^h\ 17^m$	49°	$3^h\ 21^m$	50°	$3^h\ 25^m$	51°
0	**15**	9.22287	**0.16706**	9.23960	**0.17362**	9.25595	**0.18028**	9.27193	**0.18704**
4	**16**	.22315	**.16717**	.23988	**.17373**	.25622	**.18039**	.27219	**.18715**
8	**17**	.22343	**.16728**	.24015	**.17384**	.25649	**.18050**	.27246	**.18727**
12	**18**	.22372	**.16738**	.24043	**.17395**	.25676	**.18062**	.27272	**.18738**
16	**19**	.22400	**.16749**	.24070	**.17406**	.25703	**.18073**	.27298	**.18749**
20	**20**	9.22428	**0.16760**	9.24098	**0.17417**	9.25729	**0.18084**	9.27325	**0.18761**
24	**21**	.22456	**.16771**	.24125	**.17428**	.25756	**.18095**	.27351	**.18772**
28	**22**	.22484	**.16782**	.24153	**.17439**	.25783	**.18106**	.27377	**.18783**
32	**23**	.22512	**.16793**	.24180	**.17450**	.25810	**.18118**	.27403	**.18795**
36	**24**	.22540	**.16804**	.24208	**.17461**	.25837	**.18129**	.27430	**.18806**
40	**25**	9.22569	**0.16815**	9.24235	**0.17472**	9.25864	**0.18140**	9.27456	**0.18817**
44	**26**	.22597	**.16825**	.24263	**.17483**	.25891	**.18151**	.27482	**.18829**
48	**27**	.22625	**.16836**	.24290	**.17494**	.25917	**.18162**	.27508	**.18840**
52	**28**	.22653	**.16847**	.24317	**.17505**	.25944	**.18174**	.27535	**.18852**
56	**29**	.22681	**.16858**	.24345	**.17517**	.25971	**.18185**	.27561	**.18863**
s	′	$3^h\ 14^m$	48°	$3^h\ 18^m$	49°	$3^h\ 22^m$	50°	$3^h\ 26^m$	51°
0	**30**	9.22709	**0.16869**	9.24372	**0.17528**	9.25998	**0.18196**	9.27587	**0.18874**
4	**31**	.22737	**.16880**	.24400	**.17539**	.26025	**.18207**	.27613	**.18886**
8	**32**	.22765	**.16891**	.24427	**.17550**	.26051	**.18219**	.27639	**.18897**
12	**33**	.22793	**.16902**	.24454	**.17561**	.26078	**.18230**	.27666	**.18908**
16	**34**	.22821	**.16913**	.24482	**.17572**	.26105	**.18241**	.27692	**.18920**
20	**35**	9.22849	**0.16924**	9.24509	**0.17583**	9.26132	**0.18252**	9.27718	**0.18931**
24	**36**	.22877	**.16934**	.24536	**.17594**	.26158	**.18263**	.27744	**.18943**
28	**37**	.22905	**.16945**	.24564	**.17605**	.26185	**.18275**	.27770	**.18954**
32	**38**	.22933	**.16956**	.24591	**.17616**	.26212	**.18286**	.27796	**.18965**
36	**39**	.22961	**.16967**	.24618	**.17627**	.26238	**.18297**	.27822	**.18977**
40	**40**	9.22989	**0.16978**	9.24646	**0.17638**	9.26265	**0.18308**	9.27848	**0.18988**
44	**41**	.23017	**.16989**	.24673	**.17649**	.26292	**.18320**	.27875	**.19000**
48	**42**	.23045	**.17000**	.24700	**.17661**	.26319	**.18331**	.27901	**.19011**
52	**43**	.23073	**.17011**	.24728	**.17672**	.26345	**.18342**	.27927	**.19022**
56	**44**	.23100	**.17022**	.24755	**.17683**	.26372	**.18353**	.27953	**.19034**
s	′	$3^h\ 15^m$	48°	$3^h\ 19^m$	49°	$3^h\ 23^m$	50°	$3^h\ 27^m$	51°
0	**45**	9.23128	**0.17033**	9.24782	**0.17694**	9.26398	**0.18365**	9.27979	**0.19045**
4	**46**	.23156	**.17044**	.24809	**.17705**	.26425	**.18376**	.28005	**.19057**
8	**47**	.23184	**.17055**	.24837	**.17716**	.26452	**.18387**	.28031	**.19068**
12	**48**	.23212	**.17066**	.24864	**.17727**	.26478	**.18399**	.28057	**.19080**
16	**49**	.23240	**.17076**	.24891	**.17738**	.26505	**.18410**	.28083	**.19091**
20	**50**	9.23268	**0.17087**	9.24918	**0.17749**	9.26532	**0.18421**	9.28109	**0.19102**
24	**51**	.23295	**.17098**	.24945	**.17760**	.26558	**.18432**	.28135	**.19114**
28	**52**	.23323	**.17109**	.24973	**.17772**	.26585	**.18444**	.28161	**.19125**
32	**53**	.23351	**.17120**	.25000	**.17783**	.26611	**.18455**	.28187	**.19137**
36	**54**	.23379	**.17131**	.25027	**.17794**	.26638	**.18466**	.28213	**.19148**
40	**55**	9.23407	**0.17142**	9.25054	**0.17805**	9.26664	**0.18478**	9.28239	**0.19160**
44	**56**	.23434	**.17153**	.25081	**.17816**	.26691	**.18489**	.28265	**.19171**
48	**57**	.23462	**.17164**	.25108	**.17827**	.26717	**.18500**	.28291	**.19183**
52	**58**	.23490	**.17175**	.25135	**.17838**	.26744	**.18511**	.28317	**.19194**
56	**59**	.23518	**.17186**	.25163	**.17849**	.26770	**.18523**	.28342	**.19205**
60	**60**	9.23545	**0.17197**	9.25190	**0.17861**	9.26797	**0.18534**	9.28368	**0.19217**

s	′	$3^h\ 28^m$	52°	$3^h\ 32^m$	53°	$3^h\ 36^m$	54°	$3^h\ 40^m$	55°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	9.28368	**0.19217**	9.29906	**0.19909**	9.31409	**0.20611**	9.32881	**0.21321**
4	**1**	.28394	**.19228**	.29931	**.19921**	.31434	**.20623**	.32905	**.21333**
8	**2**	.28420	**.19240**	.29956	**.19932**	.31459	**.20634**	.32930	**.21345**
12	**3**	.28446	**.19251**	.29981	**.19944**	.31484	**.20646**	.32954	**.21357**
16	**4**	.28472	**.19263**	.30007	**.19956**	.31508	**.20658**	.32978	**.21369**
20	**5**	9.28498	**0.19274**	9.30032	**0.19967**	9.31533	**0.20670**	9.33002	**0.21381**
24	**6**	.28524	**.19286**	.30057	**.19979**	.31558	**.20681**	.33027	**.21393**
28	**7**	.28549	**.19297**	.30083	**.19991**	.31583	**.20693**	.33051	**.21405**
32	**8**	.28575	**.19309**	.30108	**.20002**	.31607	**.20705**	.33075	**.21417**
36	**9**	.28601	**.19320**	.30133	**.20014**	.31632	**.20717**	.33099	**.21429**
40	**10**	9.28627	**0.19332**	9.30158	**0.20026**	9.31657	**0.20729**	9.33123	**0.21440**
44	**11**	.28653	**.19343**	.30184	**.20037**	.31682	**.20740**	.33148	**.21452**
48	**12**	.28679	**.19355**	.30209	**.20049**	.31706	**.20752**	.33172	**.21464**
52	**13**	.28704	**.19366**	.30234	**.20060**	.31731	**.20764**	.33196	**.21476**
56	**14**	.28730	**.19378**	.30259	**.20072**	.31756	**.20776**	.33220	**.21488**
s	′	$3^h\ 29^m$	52°	$3^h\ 33^m$	53°	$3^h\ 37^m$	54°	$3^h\ 41^m$	55°
0	**15**	9.28756	**0.19389**	9.30285	**0.20084**	9.31780	**0.20788**	9.33244	**0.21500**
4	**16**	.28782	**.19401**	.30310	**.20095**	.31805	**.20799**	.33268	**.21512**
8	**17**	.28807	**.19412**	.30335	**.20107**	.31830	**.20811**	.33292	**.21524**
12	**18**	.28833	**.19424**	.30360	**.20119**	.31854	**.20823**	.33317	**.21536**
16	**19**	.28859	**.19435**	.30385	**.20130**	.31879	**.20835**	.33341	**.21548**
20	**20**	9.28885	**0.19447**	9.30410	**0.20142**	9.31903	**0.20847**	9.33365	**0.21560**
24	**21**	.28910	**.19458**	.30436	**.20154**	.31928	**.20858**	.33389	**.21572**
28	**22**	.28936	**.19470**	.30461	**.20165**	.31953	**.20870**	.33413	**.21584**
32	**23**	.28962	**.19481**	.30486	**.20177**	.31977	**.20882**	.33437	**.21596**
36	**24**	.28987	**.19493**	.30511	**.20189**	.32002	**.20894**	.33461	**.21608**
40	**25**	9.29013	**0.19504**	9.30536	**0.20200**	9.32026	**0.20906**	9.33485	**0.21620**
44	**26**	.29039	**.19516**	.30561	**.20212**	.32051	**.20918**	.33509	**.21632**
48	**27**	.29064	**.19527**	.30586	**.20224**	.32076	**.20929**	.33533	**.21644**
52	**28**	.29090	**.19539**	.30611	**.20235**	.32100	**.20941**	.33557	**.21656**
56	**29**	.29116	**.19550**	.30636	**.20247**	.32125	**.20953**	.33581	**.21668**
s	′	$3^h\ 30^m$	52°	$3^h\ 34^m$	53°	$3^h\ 38^m$	54°	$3^h\ 42^m$	55°
0	**30**	9.29141	**0.19562**	9.30662	**0.20259**	9.32149	**0.20965**	9.33605	**0.21680**
4	**31**	.29167	**.19573**	.30687	**.20271**	.32174	**.20977**	.33629	**.21692**
8	**32**	.29192	**.19585**	.30712	**.20282**	.32198	**.20989**	.33653	**.21704**
12	**33**	.29218	**.19597**	.30737	**.20294**	.32223	**.21000**	.33677	**.21716**
16	**34**	.29244	**.19608**	.30762	**.20306**	.32247	**.21012**	.33701	**.21728**
20	**35**	9.29269	**0.19620**	9.30787	**0.20317**	9.32272	**0.21024**	9.33725	**0.21740**
24	**36**	.29295	**.19631**	.30812	**.20329**	.32296	**.21036**	.33749	**.21752**
28	**37**	.29320	**.19643**	.30837	**.20341**	.32321	**.21048**	.33773	**.21764**
32	**38**	.29346	**.19654**	.30862	**.20352**	.32345	**.21060**	.33797	**.21776**
36	**39**	.29371	**.19666**	.30887	**.20364**	.32370	**.21072**	.33821	**.21788**
40	**40**	9.29397	**0.19677**	9.30912	**0.20376**	9.32394	**0.21083**	9.33845	**0.21800**
44	**41**	.29422	**.19689**	.30937	**.20388**	.32418	**.21095**	.33869	**.21812**
48	**42**	.29448	**.19701**	.30962	**.20399**	.32443	**.21107**	.33893	**.21824**
52	**43**	.29473	**.19712**	.30987	**.20411**	.32467	**.21119**	.33917	**.21836**
56	**44**	.29499	**.19724**	.31012	**.20423**	.32492	**.21131**	.33941	**.21848**
s	′	$3^h\ 31^m$	52°	$3^h\ 35^m$	53°	$3^h\ 39^m$	54°	$3^h\ 43^m$	55°
0	**45**	9.29524	**0.19735**	9.31036	**0.20435**	9.32516	**0.21143**	9.33965	**0.21860**
4	**46**	.29550	**.19747**	.31061	**.20446**	.32541	**.21155**	.33988	**.21872**
8	**47**	.29575	**.19758**	.31086	**.20458**	.32565	**.21167**	.34012	**.21884**
12	**48**	.29601	**.19770**	.31111	**.20470**	.32589	**.21178**	.34036	**.21896**
16	**49**	.29626	**.19782**	.31136	**.20481**	.32614	**.21190**	.34060	**.21908**
20	**50**	9.29652	**0.19793**	9.31161	**0.20493**	9.32638	**0.21202**	9.34084	**0.21920**
24	**51**	.29677	**.19805**	.31186	**.20505**	.32662	**.21214**	.34108	**.21932**
28	**52**	.29703	**.19816**	.31211	**.20517**	.32687	**.21226**	.34132	**.21944**
32	**53**	.29728	**.19828**	.31236	**.20528**	.32711	**.21238**	.34155	**.21956**
36	**54**	.29753	**.19840**	.31260	**.20540**	.32735	**.21250**	.34179	**.21968**
40	**55**	9.29779	**0.19851**	9.31285	**0.20552**	9.32760	**0.21262**	9.34203	**0.21980**
44	**56**	.29804	**.19863**	.31310	**.20564**	.32784	**.21274**	.34227	**.21992**
48	**57**	.29829	**.19874**	.31335	**.20575**	.32808	**.21285**	.34251	**.22004**
52	**58**	.29855	**.19886**	.31360	**.20587**	.32833	**.21297**	.34274	**.22016**
56	**59**	.29880	**.19898**	.31385	**.20599**	.32857	**.21309**	.34298	**.22028**
60	**60**	9.29906	**0.19909**	9.31409	**0.20611**	9.32881	**0.21321**	9.34322	**0.22040**

s	′	$3^h\ 44^m$	56°	$3^h\ 48^m$	57°	$3^h\ 52^m$	58°	$3^h\ 56^m$	59°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	9.34322	**0.22040**	9.35733	**0.22768**	9.37114	**0.23504**	9.38468	**0.24248**
4	**1**	.34346	**.22052**	.35756	**.22780**	.37137	**.23516**	.38490	**.24261**
8	**2**	.34369	**.22064**	.35779	**.22792**	.37160	**.23529**	.38512	**.24273**
12	**3**	.34393	**.22077**	.35802	**.22805**	.37183	**.23541**	.38535	**.24286**
16	**4**	.34417	**.22089**	.35826	**.22817**	.37205	**.23553**	.38557	**.24298**
20	**5**	9.34441	**0.22101**	9.35849	**0.22829**	9.37228	**0.23566**	9.38579	**0.24310**
24	**6**	.34464	**.22113**	.35872	**.22841**	.37251	**.23578**	.38602	**.24323**
28	**7**	.34488	**.22125**	.35895	**.22853**	.37274	**.23590**	.38624	**.24335**
32	**8**	.34512	**.22137**	.35918	**.22866**	.37296	**.23603**	.38646	**.24348**
36	**9**	.34535	**.22149**	.35942	**.22878**	.37319	**.23615**	.38668	**.24360**
40	**10**	9.34559	**0.22161**	9.35965	**0.22890**	9.37342	**0.23627**	9.38691	**0.24373**
44	**11**	.34583	**.22173**	.35988	**.22902**	.37364	**.23640**	.38713	**.24385**
48	**12**	.34606	**.22185**	.36011	**.22915**	.37387	**.23652**	.38735	**.24398**
52	**13**	.34630	**.22197**	.36034	**.22927**	.37410	**.23665**	.38757	**.24410**
56	**14**	.34654	**.22209**	.36058	**.22939**	.37433	**.23677**	.38780	**.24423**
s	′	$3^h\ 45^m$	56°	$3^h\ 49^m$	57°	$3^h\ 53^m$	58°	$3^h\ 57^m$	59°
0	**15**	9.34677	**0.22221**	9.36081	**0.22951**	9.37455	**0.23689**	9.38802	**0.24435**
4	**16**	.34701	**.22234**	.36104	**.22964**	.37478	**.23702**	.38824	**.24448**
8	**17**	.34725	**.22246**	.36127	**.22976**	.37501	**.23714**	.38846	**.24460**
12	**18**	.34748	**.22258**	.36150	**.22988**	.37523	**.23726**	.38868	**.24473**
16	**19**	.34772	**.22270**	.36173	**.23000**	.37546	**.23739**	.38891	**.24485**
20	**20**	9.34795	**0.22282**	9.36196	**0.23012**	9.37569	**0.23751**	9.38913	**0.24498**
24	**21**	.34819	**.22294**	.36219	**.23025**	.37591	**.23764**	.38935	**.24510**
28	**22**	.34843	**.22306**	.36243	**.23037**	.37614	**.23776**	.38957	**.24523**
32	**23**	.34866	**.22318**	.36266	**.23049**	.37636	**.23788**	.38979	**.24535**
36	**24**	.34890	**.22330**	.36289	**.23061**	.37659	**.23801**	.39002	**.24548**
40	**25**	9.34913	**0.22343**	9.36312	**0.23074**	9.37682	**0.23813**	9.39024	**0.24560**
44	**26**	.34937	**.22355**	.36335	**.23086**	.37704	**.23825**	.39046	**.24573**
48	**27**	.34960	**.22367**	.36358	**.23098**	.37727	**.23838**	.39068	**.24586**
52	**28**	.34984	**.22379**	.36381	**.23110**	.37749	**.23850**	.39090	**.24598**
56	**29**	.35007	**.22391**	.36404	**.23123**	.37772	**.23863**	.39112	**.24611**
s	′	$3^h\ 46^m$	56°	$3^h\ 50^m$	57°	$3^h\ 54^m$	58°	$3^h\ 58^m$	59°
0	**30**	9.35031	**0.22403**	9.36427	**0.23135**	9.37794	**0.23875**	9.39134	**0.24623**
4	**31**	.35054	**.22415**	.36450	**.23147**	.37817	**.23887**	.39156	**.24636**
8	**32**	.35078	**.22427**	.36473	**.23160**	.37840	**.23900**	.39178	**.24648**
12	**33**	.35101	**.22440**	.36496	**.23172**	.37862	**.23912**	.39201	**.24661**
16	**34**	.35125	**.22452**	.36519	**.23184**	.37885	**.23925**	.39223	**.24673**
20	**35**	9.35148	**0.22464**	9.36542	**0.23196**	9.37907	**0.23937**	9.39245	**0.24686**
24	**36**	.35172	**.22476**	.36565	**.23209**	.37930	**.23950**	.39267	**.24698**
28	**37**	.35195	**.22488**	.36588	**.23221**	.37952	**.23962**	.39289	**.24711**
32	**38**	.35219	**.22500**	.36611	**.23233**	.37975	**.23974**	.39311	**.24723**
36	**39**	.35242	**.22512**	.36634	**.23246**	.37997	**.23987**	.39333	**.24736**
40	**40**	9.35266	**0.22525**	9.36657	**0.23258**	9.38020	**0.23999**	9.39355	**0.24749**
44	**41**	.35289	**.22537**	.36680	**.23270**	.38042	**.24012**	.39377	**.24761**
48	**42**	.35312	**.22549**	.36703	**.23282**	.38065	**.24024**	.39399	**.24774**
52	**43**	.35336	**.22561**	.36726	**.23295**	.38087	**.24036**	.39421	**.24786**
56	**44**	.35359	**.22573**	.36749	**.23307**	.38110	**.24049**	.39443	**.24799**
s	′	$3^h\ 47^m$	56°	$3^h\ 51^m$	57°	$3^h\ 55^m$	58°	$3^h\ 59^m$	59°
0	**45**	9.35383	**0.22585**	9.36772	**0.23319**	9.38132	**0.24061**	9.39465	**0.24811**
4	**46**	.35406	**.22598**	.36794	**.23332**	.38154	**.24074**	.39487	**.24824**
8	**47**	.35429	**.22610**	.36817	**.23344**	.38177	**.24086**	.39509	**.24836**
12	**48**	.35453	**.22622**	.36840	**.23356**	.38199	**.24099**	.39531	**.24849**
16	**49**	.35476	**.22634**	.36863	**.23368**	.38222	**.24111**	.39553	**.24862**
20	**50**	9.35500	**0.22646**	9.36886	**0.23381**	9.38244	**0.24124**	9.39575	**0.24874**
24	**51**	.35523	**.22658**	.36909	**.23393**	.38267	**.24136**	.39597	**.24887**
28	**52**	.35546	**.22671**	.36932	**.23405**	.38289	**.24148**	.39619	**.24899**
32	**53**	.35570	**.22683**	.36955	**.23418**	.38311	**.24161**	.39641	**.24912**
36	**54**	.35593	**.22695**	.36977	**.23430**	.38334	**.24173**	.39663	**.24924**
40	**55**	9.35616	**0.22707**	9.37000	**0.23442**	9.38356	**0.24186**	9.39685	**0.24937**
44	**56**	.35639	**.22719**	.37023	**.23455**	.38378	**.24198**	.39706	**.24950**
48	**57**	.35663	**.22731**	.37046	**.23467**	.38401	**.24211**	.39728	**.24962**
52	**58**	.35686	**.22744**	.37069	**.23479**	.38423	**.24223**	.39750	**.24975**
56	**59**	.35709	**.22756**	.37091	**.23492**	.38445	**.24236**	.39772	**.24987**
60	**60**	9.35733	**0.22768**	9.37114	**0.23504**	9.38468	**0.24248**	9.39794	**0.25000**

Table 10. Haversine Table

s	′	$4^h\ 0^m$ Hav.	60° No.	$4^h\ 4^m$ Hav.	61° No.	$4^h\ 8^m$ Hav.	62° No.	$4^h\ 12^m$ Hav.	63° No.
0	0	9.39794	**0.25000**	9.41094	**0.25760**	9.42368	**0.26526**	9.43617	**0.27300**
4	1	.39816	**.25013**	.41115	**.25772**	.42389	**.26539**	.43638	**.27313**
8	2	.39838	**.25025**	.41137	**.25785**	.42410	**.26552**	.43658	**.27326**
12	3	.39860	**.25038**	.41158	**.25798**	.42431	**.26565**	.43679	**.27339**
16	4	.39881	**.25050**	.41180	**.25810**	.42452	**.26578**	.43699	**.27352**
20	5	9.39903	**0.25063**	9.41201	**0.25823**	9.42473	**0.26591**	9.43720	**0.27365**
24	6	.39925	**.25076**	.41222	**.25836**	.42494	**.26604**	.43741	**.27378**
28	7	.39947	**.25088**	.41244	**.25849**	.42515	**.26616**	.43761	**.27391**
32	8	.39969	**.25101**	.41265	**.25861**	.42536	**.26629**	.43782	**.27404**
36	9	.39991	**.25113**	.41287	**.25874**	.42557	**.26642**	.43802	**.27417**
40	10	9.40012	**0.25126**	9.41308	**0.25887**	9.42578	**0.26655**	9.43823	**0.27430**
44	11	.40034	**.25139**	.41329	**.25900**	.42599	**.26668**	.43843	**.27443**
48	12	.40056	**.25151**	.41351	**.25912**	.42620	**.26681**	.43864	**.27456**
52	13	.40078	**.25164**	.41372	**.25925**	.42641	**.26694**	.43884	**.27469**
56	14	.40100	**.25177**	.41393	**.25938**	.42662	**.26706**	.43905	**.27482**
s	′	$4^h\ 1^m$	60°	$4^h\ 5^m$	61°	$4^h\ 9^m$	62°	$4^h\ 13^m$	63°
0	15	9.40121	**0.25189**	9.41415	**0.25951**	9.42682	**0.26719**	9.43926	**0.27495**
4	16	.40143	**.25202**	.41436	**.25963**	.42703	**.26732**	.43946	**.27508**
8	17	.40165	**.25214**	.41457	**.25976**	.42724	**.26745**	.43967	**.27521**
12	18	.40187	**.25227**	.41479	**.25989**	.42745	**.26758**	.43987	**.27534**
16	19	.40208	**.25240**	.41500	**.26002**	.42766	**.26771**	.44008	**.27547**
20	20	9.40230	**0.25252**	9.41521	**0.26014**	9.42787	**0.26784**	9.44028	**0.27560**
24	21	.40252	**.25265**	.41543	**.26027**	.42808	**.26797**	.44048	**.27573**
28	22	.40274	**.25278**	.41564	**.26040**	.42829	**.26809**	.44069	**.27586**
32	23	.40295	**.25290**	.41585	**.26053**	.42850	**.26822**	.44089	**.27599**
36	24	.40317	**.25303**	.41606	**.26065**	.42870	**.26835**	.44110	**.27612**
40	25	9.40339	**0.25316**	9.41628	**0.26078**	9.42891	**0.26848**	9.44130	**0.27625**
44	26	.40360	**.25328**	.41649	**.26091**	.42912	**.26861**	.44151	**.27638**
48	27	.40382	**.25341**	.41670	**.26104**	.42933	**.26874**	.44171	**.27651**
52	28	.40404	**.25354**	.41692	**.26117**	.42954	**.26887**	.44192	**.27664**
56	29	.40425	**.25366**	.41713	**.26129**	.42975	**.26900**	.44212	**.27677**
s	′	$4^h\ 2^m$	60°	$4^h\ 6^m$	61°	$4^h\ 10^m$	62°	$4^h\ 14^m$	63°
0	30	9.40447	**0.25379**	9.41734	**0.26142**	9.42996	**0.26913**	9.44232	**0.27690**
4	31	.40469	**.25391**	.41755	**.26155**	.43016	**.26925**	.44253	**.27703**
8	32	.40490	**.25404**	.41776	**.26168**	.43037	**.26938**	.44273	**.27716**
12	33	.40512	**.25417**	.41798	**.26180**	.43058	**.26951**	.44294	**.27729**
16	34	.40534	**.25429**	.41819	**.26193**	.43079	**.26964**	.44314	**.27742**
20	35	9.40555	**0.25442**	9.41840	**0.26206**	9.43100	**0.26977**	9.44334	**0.27755**
24	36	.40577	**.25455**	.41861	**.26219**	.43120	**.26990**	.44355	**.27768**
28	37	.40599	**.25467**	.41882	**.26232**	.43141	**.27003**	.44375	**.27781**
32	38	.40620	**.25480**	.41904	**.26244**	.43162	**.27016**	.44396	**.27794**
36	39	.40642	**.25493**	.41925	**.26257**	.43183	**.27029**	.44416	**.27807**
40	40	9.40663	**0.25506**	9.41946	**0.26270**	9.43203	**0.27042**	9.44436	**0.27820**
44	41	.40685	**.25518**	.41967	**.26283**	.43224	**.27055**	.44457	**.27833**
48	42	.40707	**.25531**	.41988	**.26296**	.43245	**.27068**	.44477	**.27846**
52	43	.40728	**.25544**	.42009	**.26308**	.43266	**.27080**	.44497	**.27859**
56	44	.40750	**.25556**	.42031	**.26321**	.43286	**.27093**	.44518	**.27873**
s	′	$4^h\ 3^m$	60°	$4^h\ 7^m$	61°	$4^h\ 11^m$	62°	$4^h\ 15^m$	63°
0	45	9.40771	**0.25569**	9.42052	**0.26334**	9.43307	**0.27106**	9.44538	**0.27886**
4	46	.40793	**.25582**	.42073	**.26347**	.43328	**.27119**	.44558	**.27899**
8	47	.40814	**.25594**	.42094	**.26360**	.43348	**.27132**	.44579	**.27912**
12	48	.40836	**.25607**	.42115	**.26372**	.43369	**.27145**	.44599	**.27925**
16	49	.40858	**.25620**	.42136	**.26385**	.43390	**.27158**	.44619	**.27938**
20	50	9.40879	**0.25632**	9.42157	**0.26398**	9.43411	**0.27171**	9.44639	**0.27951**
24	51	.40900	**.25645**	.42178	**.26411**	.43431	**.27184**	.44660	**.27964**
28	52	.40922	**.25658**	.42199	**.26424**	.43452	**.27197**	.44680	**.27977**
32	53	.40943	**.25671**	.42221	**.26437**	.43473	**.27210**	.44700	**.27990**
36	54	.40965	**.25683**	.42242	**.26449**	.43493	**.27223**	.44721	**.28003**
40	55	9.40986	**0.25696**	9.42263	**0.26462**	9.43514	**0.27236**	9.44741	**0.28016**
44	56	.41008	**.25709**	.42284	**.26475**	.43535	**.27249**	.44761	**.28029**
48	57	.41029	**.25721**	.42305	**.26488**	.43555	**.27262**	.44781	**.28042**
52	58	.41051	**.25734**	.42326	**.26501**	.43576	**.27275**	.44801	**.28055**
56	59	.41072	**.25747**	.42347	**.26514**	.43596	**.27288**	.44822	**.28068**
60	60	9.41094	**0.25760**	9.42368	**0.26526**	9.43617	**0.27300**	9.44842	**0.28081**

s	'	$4^h\ 16^m$ Hav.	64° No.	$4^h\ 20^m$ Hav.	65° No.	$4^h\ 24^m$ Hav.	66° No.	$4^h\ 28^m$ Hav.	67° No.
0	**0**	9.44842	**0.28081**	9.46043	**0.28869**	9.47222	**0.29663**	9.48378	**0.30463**
4	**1**	.44862	**.28095**	.46063	**.28882**	.47241	**.29676**	.48397	**.30477**
8	**2**	.44882	**.28108**	.46083	**.28895**	.47261	**.29690**	.48416	**.30490**
12	**3**	.44903	**.28121**	.46103	**.28909**	.47280	**.29703**	.48435	**.30504**
16	**4**	.44923	**.28134**	.46123	**.28922**	.47300	**.29716**	.48454	**.30517**
20	**5**	9.44943	**0.28147**	9.46142	**0.28935**	9.47319	**0.29730**	9.48473	**0.30530**
24	**6**	.44963	**.28160**	.46162	**.28948**	.47338	**.29743**	.48492	**.30544**
28	**7**	.44983	**.28173**	.46182	**.28961**	.47358	**.29756**	.48511	**.30557**
32	**8**	.45003	**.28186**	.46202	**.28975**	.47377	**.29770**	.48530	**.30571**
36	**9**	.45024	**.28199**	.46222	**.28988**	.47397	**.29783**	.48549	**.30584**
40	**10**	9.45044	**0.28212**	9.46241	**0.29001**	9.47416	**0.29796**	9.48568	**0.30597**
44	**11**	.45064	**.28225**	.46261	**.29014**	.47435	**.29809**	.48587	**.30611**
48	**12**	.45084	**.28238**	.46281	**.29027**	.47455	**.29823**	.48607	**.30624**
52	**13**	.45104	**.28252**	.46301	**.29041**	.47474	**.29836**	.48626	**.30638**
56	**14**	.45124	**.28265**	.46320	**.29054**	.47493	**.29849**	.48645	**.30651**
s	'	$4^h\ 17^m$	64°	$4^h\ 21^m$	65°	$4^h\ 25^m$	66°	$4^h\ 29^m$	67°
0	**15**	9.45144	**0.28278**	9.46340	**0.29067**	9.47513	**0.29863**	9.48664	**0.30664**
4	**16**	.45165	**.28291**	.46360	**.29080**	.47532	**.29876**	.48683	**.30678**
8	**17**	.45185	**.28304**	.46380	**.29093**	.47552	**.29889**	.48702	**.30691**
12	**18**	.45205	**.28317**	.46399	**.29107**	.47571	**.29903**	.48720	**.30705**
16	**19**	.45225	**.28330**	.46419	**.29120**	.47590	**.29916**	.48739	**.30718**
20	**20**	9.45245	**0.28343**	9.46439	**0.29133**	9.47610	**0.29929**	9.48758	**0.30732**
24	**21**	.45265	**.28356**	.46458	**.29146**	.47629	**.29943**	.48777	**.30745**
28	**22**	.45285	**.28369**	.46478	**.29160**	.47648	**.29956**	.48796	**.30758**
32	**23**	.45305	**.28383**	.46498	**.29173**	.47668	**.29969**	.48815	**.30772**
36	**24**	.45325	**.28396**	.46517	**.29186**	.47687	**.29983**	.48834	**.30785**
40	**25**	9.45345	**0.28409**	9.46537	**0.29199**	9.47706	**0.29996**	9.48853	**0.30799**
44	**26**	.45365	**.28422**	.46557	**.29212**	.47725	**.30009**	.48872	**.30812**
48	**27**	.45385	**.28435**	.46576	**.29226**	.47745	**.30023**	.48891	**.30826**
52	**28**	.45405	**.28448**	.46596	**.29239**	.47764	**.30036**	.48910	**.30839**
56	**29**	.45426	**.28461**	.46616	**.29252**	.47783	**.30049**	.48929	**.30852**
s	'	$4^h\ 18^m$	64°	$4^h\ 22^m$	65°	$4^h\ 26^m$	66°	$4^h\ 30^m$	67°
0	**30**	9.45446	**0.28474**	9.46635	**0.29265**	9.47803	**0.30063**	9.48948	**0.30866**
4	**31**	.45466	**.28488**	.46655	**.29279**	.47822	**.30076**	.48967	**.30879**
8	**32**	.45486	**.28501**	.46675	**.29292**	.47841	**.30089**	.48986	**.30893**
12	**33**	.45506	**.28514**	.46694	**.29305**	.47860	**.30103**	.49004	**.30906**
16	**34**	.45526	**.28527**	.46714	**.29318**	.47880	**.30116**	.49023	**.30920**
20	**35**	9.45546	**0.28540**	9.46733	**0.29332**	9.47899	**0.30129**	9.49042	**0.30933**
24	**36**	.45566	**.28553**	.46753	**.29345**	.47918	**.30143**	.49061	**.30946**
28	**37**	.45586	**.28566**	.46773	**.29358**	.47937	**.30156**	.49080	**.30960**
32	**38**	.45606	**.28580**	.46792	**.29371**	.47957	**.30169**	.49099	**.30973**
36	**39**	.45625	**.28593**	.46812	**.29385**	.47976	**.30183**	.49118	**.30987**
40	**40**	9.45645	**0.28606**	9.46831	**0.29398**	9.47995	**0.30196**	9.49137	**0.31000**
44	**41**	.45665	**.28619**	.46851	**.29411**	.48014	**.30209**	.49155	**.31014**
48	**42**	.45685	**.28632**	.46871	**.29424**	.48033	**.30223**	.49174	**.31027**
52	**43**	.45705	**.28645**	.46890	**.29438**	.48053	**.30236**	.49193	**.31041**
56	**44**	.45725	**.28658**	.46910	**.29451**	.48072	**.30249**	.49212	**.31054**
s	'	$4^h\ 19^m$	64°	$4^h\ 23^m$	65°	$4^h\ 27^m$	66°	$4^h\ 31^m$	67°
0	**45**	9.45745	**0.28672**	9.46929	**0.29464**	9.48091	**0.30263**	9.49231	**0.31068**
4	**46**	.45765	**.28685**	.46949	**.29477**	.48110	**.30276**	.49250	**.31081**
8	**47**	.45785	**.28698**	.46968	**.29491**	.48129	**.30290**	.49268	**.31095**
12	**48**	.45805	**.28711**	.46988	**.29504**	.48148	**.30303**	.49287	**.31108**
16	**49**	.45825	**.28724**	.47007	**.29517**	.48168	**.30316**	.49306	**.31121**
20	**50**	9.45845	**0.28737**	9.47027	**0.29530**	9.48187	**0.30330**	9.49325	**0.31135**
24	**51**	.45865	**.28751**	.47046	**.29544**	.48206	**.30343**	.49344	**.31148**
28	**52**	.45884	**.28764**	.47066	**.29557**	.48225	**.30356**	.49362	**.31162**
32	**53**	.45904	**.28777**	.47085	**.29570**	.48244	**.30370**	.49481	**.31175**
36	**54**	.45924	**.28790**	.47105	**.29583**	.48263	**.30383**	.49400	**.31189**
40	**55**	9.45944	**0.28803**	9.47124	**0.29597**	9.48282	**0.30397**	9.49419	**0.31202**
44	**56**	.45964	**.28816**	.47144	**.29610**	.48302	**.30410**	.49437	**.31216**
48	**57**	.45984	**.28830**	.47163	**.29623**	.48321	**.30423**	.49456	**.31229**
52	**58**	.46004	**.28843**	,47183	**.29637**	.48340	**.30437**	.49475	**.31243**
56	**59**	.46023	**.28856**	.47202	**.29650**	.48359	**.30450**	.49494	**.31256**
60	**60**	9.46043	**0.28869**	9.47222	**0.29663**	9.48378	**0.30463**	9.49512	**0.31270**

s	′	$4^h\ 32^m$ Hav.	68° No.	$4^h\ 36^m$ Hav.	69° No.	$4^h\ 40^m$ Hav.	70° No.	$4^h\ 44^m$ Hav.	71° No.
0	**0**	9.49512	**0.31270**	9.50626	**0.32082**	9.51718	**0.32899**	9.52791	**0.33722**
4	**1**	.49531	**.31283**	.50644	**.32095**	.51736	**.32913**	.52809	**.33735**
8	**2**	.49550	**.31297**	.50662	**.32109**	.51754	**.32926**	.52826	**.33749**
12	**3**	.49568	**.31310**	.50681	**.32122**	.51772	**.32940**	.52844	**.33763**
16	**4**	.49587	**.31324**	.50699	**.32136**	.51790	**.32954**	.52862	**.33777**
20	**5**	9.49606	**0.31337**	9.50717	**0.32150**	9.51808	**0.32967**	9.52879	**0.33790**
24	**6**	.49625	**.31351**	.50736	**.32163**	.51826	**.32981**	.52897	**.33804**
28	**7**	.49643	**.31364**	.50754	**.32177**	.51844	**.32995**	.52915	**.33818**
32	**8**	.49662	**.31378**	.50772	**.32190**	.51862	**.33008**	.52932	**.33832**
36	**9**	.49681	**.31391**	.50791	**.32204**	.51880	**.33022**	.52950	**.33845**
40	**10**	9.49699	**0.31405**	9.50809	**0.32217**	9.51898	**0.33036**	9.52968	**0.33859**
44	**11**	.49718	**.31418**	.50827	**.32231**	.51916	**.33049**	.52985	**.33873**
48	**12**	.49737	**.31432**	.50846	**.32245**	.51934	**.33063**	.53003	**.33887**
52	**13**	.49755	**.31445**	.50864	**.32258**	.51952	**.33077**	.53021	**.33900**
56	**14**	.49774	**.31459**	.50882	**.32272**	.51970	**.33090**	.53038	**.33914**
s	′	$4^h\ 33^m$	68°	$4^h\ 37^m$	69°	$4^h\ 41^m$	70°	$4^h\ 45^m$	71°
0	**15**	9.49793	**0.31472**	9.50901	**0.32285**	9.51988	**0.33104**	9.53056	**0.33928**
4	**16**	.49811	**.31486**	.50919	**.32299**	.52006	**.33118**	.53073	**.33942**
8	**17**	.49830	**.31499**	.50937	**.32313**	.52024	**.33132**	.53091	**.33956**
12	**18**	.49849	**.31513**	.50956	**.32326**	.52042	**.33145**	.53109	**.33969**
16	**19**	.49867	**.31526**	.50974	**.32340**	.52060	**.33159**	.53126	**.33983**
20	**20**	9.49886	**0.31540**	9.50992	**0.32353**	9.52078	**0.33173**	9.53144	**0.33997**
24	**21**	.49904	**.31553**	.51010	**.32367**	.52096	**.33186**	.53162	**.34011**
28	**22**	.49923	**.31567**	.51029	**.32381**	.52114	**.33200**	.53179	**.34024**
32	**23**	.49942	**.31580**	.51047	**.32394**	.52132	**.33214**	.53197	**.34038**
36	**24**	.49960	**.31594**	.51065	**.32408**	.52150	**.33227**	.53214	**.34052**
40	**25**	9.49979	**0.31607**	9.51083	**0.32422**	9.52168	**0.33241**	9.53232	**0.34066**
44	**26**	.49997	**.31621**	.51102	**.32435**	.52185	**.33255**	.53249	**.34080**
48	**27**	.50016	**.31634**	.51120	**.32449**	.52203	**.33269**	.53267	**.34093**
52	**28**	.50034	**.31648**	.51138	**.32462**	.52221	**.33282**	.53285	**.34107**
56	**29**	.50053	**.31661**	.51156	**.32476**	.52239	**.33296**	.53302	**.34121**
s	′	$4^h\ 34^m$	68°	$4^h\ 38^m$	69°	$4^h\ 42^m$	70°	$4^h\ 46^m$	71°
0	**30**	9.50072	**0.31675**	9.51174	**0.32490**	9.52257	**0.33310**	9.53320	**0.34135**
4	**31**	.50090	**.31688**	.51193	**.32503**	.52275	**.33323**	.53337	**.34149**
8	**32**	.50109	**.31702**	.51211	**.32517**	.52293	**.33337**	.53355	**.34162**
12	**33**	.50127	**.31716**	.51229	**.32531**	.52311	**.33351**	.53372	**.34176**
16	**34**	.50146	**.31729**	.51247	**.32544**	.52328	**.33365**	.53390	**.34190**
20	**35**	9.50164	**0.31742**	9.51265	**0.32558**	9.52346	**0.33378**	9.53407	**0.34204**
24	**36**	.50183	**.31756**	.51284	**.32571**	.52364	**.33392**	.53425	**.34218**
28	**37**	.50201	**.31770**	.51302	**.32585**	.52382	**.33406**	.53442	**.34231**
32	**38**	.50220	**.31783**	.51320	**.32599**	.52400	**.33419**	.53460	**.34245**
36	**39**	.50238	**.31797**	.51338	**.32612**	.52418	**.33433**	.53477	**.34259**
40	**40**	9.50257	**0.31810**	9.51356	**0.32626**	9.52436	**0.33447**	9.53495	**0.34273**
44	**41**	.50275	**.31824**	.51374	**.32640**	.52453	**.33461**	.53512	**.34287**
48	**42**	.50294	**.31837**	.51393	**.32653**	.52471	**.33474**	.53530	**.34300**
52	**43**	.50312	**.31851**	.51411	**.32667**	.52489	**.33488**	.53547	**.34314**
56	**44**	.50331	**.31865**	.51429	**.32681**	.52507	**.33502**	.53565	**.34328**
s	′	$4^h\ 35^m$	68°	$4^h\ 39^m$	69°	$4^h\ 43^m$	70°	$4^h\ 47^m$	71°
0	**45**	9.50349	**0.31878**	9.51447	**0.32694**	9.52525	**0.33515**	9.53582	**0.34342**
4	**46**	.50368	**.31892**	.51465	**.32708**	.52542	**.33529**	.53600	**.34356**
8	**47**	.50386	**.31905**	.51483	**.32721**	.52560	**.33543**	.53617	**.34369**
12	**48**	.50405	**.31919**	.51501	**.32735**	.52578	**.33557**	.53635	**.34383**
16	**49**	.50423	**.31932**	.51519	**.32749**	.52596	**.33570**	.53652	**.34397**
20	**50**	9.50442	**0.31946**	9.51538	**0.32762**	9.52613	**0.33584**	9.53670	**0.34411**
24	**51**	.50460	**.31959**	.51556	**.32776**	.52631	**.33598**	.53687	**.34425**
28	**52**	.50478	**.31973**	.51574	**.32790**	.52649	**.33612**	.53704	**.34439**
32	**53**	.50497	**.31987**	.51592	**.32803**	.52667	**.33625**	.53722	**.34452**
36	**54**	.50515	**.32000**	.51610	**.32817**	.52684	**.33639**	.53739	**.34466**
40	**55**	9.50534	**0.32014**	9.51628	**0.32831**	9.52702	**0.33653**	9.53757	**0.34480**
44	**56**	.50552	**.32027**	.51646	**.32844**	.52720	**.33667**	.53774	**.34494**
48	**57**	.50570	**.32041**	.51664	**.32858**	.52738	**.33680**	.53792	**.34508**
52	**58**	.50589	**.32054**	.51682	**.32872**	.52755	**.33694**	.53809	**.34521**
56	**59**	.50607	**.32068**	.51700	**.32885**	.52773	**.33708**	.53826	**.34535**
60	**60**	9.50626	**0.32082**	9.51718	**0.32899**	9.52791	**0.33722**	9.53844	**0.34549**

s	′	$4^h 48^m$ Hav.	72° No.	$4^h 52^m$ Hav.	73° No.	$4^h 56^m$ Hav.	74° No.	$5^h 0^m$ Hav.	75° No.
0	**0**	9.53844	**0.34549**	9.54878	**0.35381**	9.55893	**0.36218**	9.56889	**0.37059**
4	**1**	.53861	**.34563**	.54895	**.35395**	.55909	**.36232**	.56906	**.37073**
8	**2**	.53879	**.34577**	.54912	**.35409**	.55926	**.36246**	.56922	**.37087**
12	**3**	.53896	**.34591**	.54929	**.35423**	.55943	**.36260**	.56939	**.37101**
16	**4**	.53913	**.34604**	.54946	**.35437**	.55960	**.36274**	.56955	**.37115**
20	**5**	9.53931	**0.34618**	9.54963	**0.35451**	9.55976	**0.36288**	9.56972	**0.37129**
24	**6**	.53948	**.34632**	.54980	**.35465**	.55993	**.36302**	.56988	**.37143**
28	**7**	.53966	**.34646**	.54997	**.35479**	.56010	**.36316**	.57005	**.37157**
32	**8**	.53983	**.34660**	.55014	**.35493**	.56027	**.36330**	.57021	**.37171**
36	**9**	.54000	**.34674**	.55031	**.35507**	.56043	**.36344**	.57037	**.37186**
40	**10**	9.54017	**0.34688**	9.55048	**0.35521**	9.56060	**0.36358**	9.57054	**0.37200**
44	**11**	.54035	**.34701**	.55065	**.35534**	.56077	**.36372**	.57070	**.37214**
48	**12**	.54052	**.34715**	.55082	**.35548**	.56093	**.36386**	.57087	**.37228**
52	**13**	.54069	**.34729**	.55099	**.35562**	.56110	**.36400**	.57103	**.37242**
56	**14**	.54087	**.34743**	.55116	**.35576**	.56127	**.36414**	.57119	**.37256**
s	′	$4^h 49^m$	72°	$4^h 53^m$	73°	$4^h 57^m$	74°	$5^h 1^m$	75°
0	**15**	9.54104	**0.34757**	9.55133	**0.35590**	9.56144	**0.36428**	9.57136	**0.37270**
4	**16**	.54121	**.34771**	.55150	**.35604**	.56160	**.36442**	.57152	**.37284**
8	**17**	.54139	**.34784**	.55167	**.35618**	.56177	**.36456**	.57169	**.37298**
12	**18**	.54156	**.34798**	.55184	**.35632**	.56194	**.36470**	.57185	**.37312**
16	**19**	.54173	**.34812**	.55201	**.35646**	.56210	**.36484**	.57201	**.37326**
20	**20**	9.54190	**0.34826**	9.55218	**0.35660**	9.56227	**0.36498**	9.57218	**0.37340**
24	**21**	.54208	**.34840**	.55235	**.35674**	.56244	**.36512**	.57234	**.37354**
28	**22**	.54225	**.34854**	.55252	**.35688**	.56260	**.36526**	.57250	**.37368**
32	**23**	.54242	**.34868**	.55269	**.35702**	.56277	**.36540**	.57267	**.37382**
36	**24**	.54260	**.34882**	.55286	**.35716**	.56294	**.36554**	.57283	**.37397**
40	**25**	9.54277	**0.34895**	9.55303	**0.35730**	9.56310	**0.36568**	9.57299	**0.37411**
44	**26**	.54294	**.34909**	.55320	**.35743**	.56327	**.36582**	.57316	**.37425**
48	**27**	.54311	**.34923**	.55337	**.35757**	.56343	**.36596**	.57332	**.37439**
52	**28**	.54329	**.34937**	.55354	**.35771**	.56360	**.36610**	.57348	**.37453**
56	**29**	.54346	**.34951**	.55370	**.35785**	.56377	**.36624**	.57365	**.37467**
s	′	$4^h 50^m$	72°	$4^h 54^m$	73°	$4^h 58^m$	74°	$5^h 2^m$	75°
0	**30**	9.54363	**0.34965**	9.55387	**0.35799**	9.56393	**0.36638**	9.57381	**0.37481**
4	**31**	.54380	**.34979**	.55404	**.35813**	.56410	**.36652**	.57397	**.37495**
8	**32**	.54397	**.34992**	.55421	**.35827**	.56426	**.36666**	.57414	**.37509**
12	**33**	.54415	**.35006**	.55438	**.35841**	.56443	**.36680**	.57430	**.37523**
16	**34**	.54432	**.35020**	.55455	**.35855**	.56460	**.36694**	.57446	**.37537**
20	**35**	9.54449	**0.35034**	9.55472	**0.35869**	9.56476	**0.36708**	9.57463	**0.37551**
24	**36**	.54466	**.35048**	.55489	**.35883**	.56493	**.36722**	.57479	**.37566**
28	**37**	.54483	**.35062**	.55506	**.35897**	.56509	**.36736**	.57495	**.37580**
32	**38**	.54501	**.35076**	.55523	**.35911**	.56526	**.36750**	.57511	**.37594**
36	**39**	.54518	**.35090**	.55539	**.35925**	.56543	**.36764**	.57528	**.37608**
40	**40**	9.54535	**0.35103**	9.55556	**0.35939**	9.56559	**0.36778**	9.57544	**0.37622**
44	**41**	.54552	**.35117**	.55573	**.35953**	.56576	**.36792**	.57560	**.37636**
48	**42**	.54569	**.35131**	.55590	**.35967**	.56592	**.36806**	.57577	**.37650**
52	**43**	.54587	**.35145**	.55607	**.35981**	.56609	**.36820**	.57593	**.37664**
56	**44**	.54604	**.35159**	.55624	**.35995**	.56625	**.36834**	.57609	**.37678**
s	′	$4^h 51^m$	72°	$4^h 55^m$	73°	$4^h 59^m$	74°	$5^h 3^m$	75°
0	**45**	9.54621	**0.35173**	9.55641	**0.36009**	9.56642	**0.36848**	9.57625	**0.37692**
4	**46**	.54638	**.35187**	.55657	**.36023**	.56658	**.36862**	.57642	**.37706**
8	**47**	.54655	**.35201**	.55674	**.36036**	.56675	**.36877**	.57658	**.37721**
12	**48**	.54672	**.35215**	.55691	**.36050**	.56692	**.36891**	.57674	**.37735**
16	**49**	.54689	**.35228**	.55708	**.36064**	.56708	**.36905**	.57690	**.37749**
20	**50**	9.54707	**0.35242**	9.55725	**0.36078**	9.56725	**0.36919**	9.57706	**0.37763**
24	**51**	.54724	**.35256**	.55742	**.36092**	.56741	**.36933**	.57723	**.37777**
28	**52**	.54741	**.35270**	.55758	**.36106**	.56758	**.36947**	.57739	**.37791**
32	**53**	.54758	**.35284**	.55775	**.36120**	.56774	**.36961**	.57755	**.37805**
36	**54**	.54775	**.35298**	.55792	**.36134**	.56791	**.36975**	.57771	**.37819**
40	**55**	9.54792	**0.35312**	9.55809	**0.36148**	9.56807	**0.36989**	9.57787	**0.37833**
44	**56**	.54809	**.35326**	.55826	**.36162**	.56824	**.37003**	.57804	**.37847**
48	**57**	.54826	**.35340**	.55842	**.36176**	.56840	**.37017**	.57820	**.37862**
52	**58**	.54843	**.35354**	.55859	**.36190**	.56856	**.37031**	.57836	**.37876**
56	**59**	.54860	**.35368**	.55876	**.36204**	.56873	**.37045**	.57852	**.37890**
60	**60**	9.54878	**0.35381**	9.55893	**0.36218**	9.56889	**0.37059**	9.57868	**0.37904**

s	′	$5^h\ 4^m$	76°	$5^h\ 8^m$	77°	$5^h\ 12^m$	78°	$5^h\ 16^m$	79°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	9.57868	**0.37904**	9.58830	**0.38752**	9.59774	**0.39604**	9.60702	**0.40460**
4	**1**	.57885	**.37918**	.58846	**.38767**	.59790	**.39619**	.60717	**.40474**
8	**2**	.57901	**.37932**	.58862	**.38781**	.59806	**.39633**	.60733	**.40488**
12	**3**	.57917	**.37946**	.58878	**.38795**	.59821	**.39647**	.60748	**.40502**
16	**4**	.57933	**.37960**	.58893	**.38809**	.59837	**.39661**	.60763	**.40517**
20	**5**	9.57949	**0.37974**	9.58909	**0.38823**	9.59852	**0.39676**	9.60779	**0.40531**
24	**6**	.57965	**.37989**	.58925	**.38837**	.59868	**.39690**	.60794	**.40545**
28	**7**	.57981	**.38003**	.58941	**.38852**	.59883	**.39704**	.60809	**.40560**
32	**8**	.57998	**.38017**	.58957	**.38866**	.59899	**.39718**	.60825	**.40574**
36	**9**	.58014	**.38031**	.58973	**.38880**	.59915	**.39732**	.60840	**.40588**
40	**10**	9.58030	**0.38045**	9.58989	**0.38894**	9.59930	**0.39746**	9.60855	**0.40602**
44	**11**	.58046	**.38059**	.59004	**.38908**	.59946	**.39761**	.60870	**.40617**
48	**12**	.58062	**.38073**	.59020	**.38923**	.59961	**.39775**	.60886	**.40631**
52	**13**	.58078	**.38087**	.59036	**.38937**	.59977	**.39789**	.60901	**.40645**
56	**14**	.58094	**.38102**	.59052	**.38951**	.59992	**.39803**	.60916	**.40660**
s	′	$5^h\ 5^m$	76°	$5^h\ 9^m$	77°	$5^h\ 13^m$	78°	$5^h\ 17^m$	79°
0	**15**	9.58110	**0.38116**	9.59068	**0.38965**	9.60008	**0.39818**	9.60931	**0.40674**
4	**16**	.58126	**.38130**	.59083	**.38979**	.60023	**.39832**	.60947	**.40688**
8	**17**	.58143	**.38144**	.59099	**.38994**	.60039	**.39846**	.60962	**.40702**
12	**18**	.58159	**.38158**	.59115	**.39008**	.60054	**.39861**	.60977	**.40717**
16	**19**	.58175	**.38172**	.59131	**.39022**	.60070	**.39875**	.60992	**.40731**
20	**20**	9.58191	**0.38186**	9.59147	**0.39036**	9.60085	**0.39889**	9.61008	**0.40745**
24	**21**	.58207	**.38200**	.59162	**.39050**	.60101	**.39903**	.61023	**.40760**
28	**22**	.58223	**.38215**	.59178	**.39064**	.60116	**.39918**	.61038	**.40774**
32	**23**	.58239	**.38229**	.59194	**.39079**	.60132	**.39932**	.61053	**.40788**
36	**24**	.58255	**.38243**	.59210	**.39093**	.60147	**.39946**	.61069	**.40802**
40	**25**	9.58271	**0.38257**	9.59225	**0.39107**	9.60163	**0.39960**	9.61084	**0.40817**
44	**26**	.58287	**.38271**	.59241	**.39121**	.60178	**.39975**	.61099	**.40831**
48	**27**	.58303	**.38285**	.59257	**.39135**	.60194	**.39989**	.61114	**.40845**
52	**28**	.58319	**.38299**	.59273	**.39150**	.60209	**.40003**	.61129	**.40860**
56	**29**	.58335	**.38314**	.59289	**.39164**	.60225	**.40017**	.61145	**.40874**
s	′	$5^h\ 6^m$	76°	$5^h\ 10^m$	77°	$5^h\ 14^m$	78°	$5^h\ 18^m$	79°
0	**30**	9.58351	**0.38328**	9.59304	**0.39178**	9.60240	**0.40032**	9.61160	**0.40888**
4	**31**	.58367	**.38342**	.59320	**.39192**	.60256	**.40046**	.61175	**.40903**
8	**32**	.58383	**.38356**	.59336	**.39206**	.60271	**.40060**	.61190	**.40917**
12	**33**	.58399	**.38370**	.59351	**.39221**	.60287	**.40074**	.61205	**.40931**
16	**34**	.58415	**.38384**	.59367	**.39235**	.60302	**.40089**	.61221	**.40945**
20	**35**	9.58431	**0.38398**	9.59383	**0.39249**	9.60318	**0.40103**	9.61236	**0.40960**
24	**36**	.58447	**.38413**	.59399	**.39263**	.60333	**.40117**	.61251	**.40974**
28	**37**	.58463	**.38427**	.59414	**.39277**	.60348	**.40131**	.61266	**.40988**
32	**38**	.58479	**.38441**	.59430	**.39292**	.60364	**.40146**	.61281	**.41003**
36	**39**	.58495	**.38455**	.59446	**.39306**	.60379	**.40160**	.61296	**.41017**
40	**40**	9.58511	**0.38469**	9.59461	**0.39320**	9.60395	**0.40174**	9.61312	**0.41031**
44	**41**	.58527	**.38483**	.59477	**.39334**	.60410	**.40188**	.61327	**.41046**
48	**42**	.58543	**.38498**	.59493	**.39348**	.60426	**.40203**	.61342	**.41060**
52	**43**	.58559	**.38512**	.59508	**.39363**	.60441	**.40217**	.61357	**.41074**
56	**44**	.58575	**.38526**	.59524	**.39377**	.60456	**.40231**	.61372	**.41089**
s	′	$5^h\ 7^m$	76°	$5^h\ 11^m$	77°	$5^h\ 15^m$	78°	$5^h\ 19^m$	79°
0	**45**	9.58591	**0.38540**	9.59540	**0.39391**	9.60472	**0.40245**	9.61387	**0.41103**
4	**46**	.58607	**.38554**	.59556	**.39405**	.60487	**.40260**	.61402	**.41117**
8	**47**	.58623	**.38568**	.59571	**.39420**	.60502	**.40274**	.61417	**.41131**
12	**48**	.58639	**.38582**	.59587	**.39434**	.60518	**.40288**	.61433	**.41146**
16	**49**	.58655	**.38597**	.59602	**.39448**	.60533	**.40303**	.61448	**.41160**
20	**50**	9.58671	**0.38611**	9.59618	**0.39462**	9.60549	**0.40317**	9.61463	**0.41174**
24	**51**	.58687	**.38625**	.59634	**.39476**	.60564	**.40331**	.61478	**.41189**
28	**52**	.58703	**.38639**	.59649	**.39491**	.60579	**.40345**	.61493	**.41203**
32	**53**	.58719	**.38653**	.59665	**.39505**	.60595	**.40360**	.61508	**.41217**
36	**54**	.58735	**.38667**	.59681	**.39519**	.60610	**.40374**	.61523	**.41232**
40	**55**	9.58750	**0.38682**	9.59696	**0.39533**	9.60625	**0.40388**	9.61538	**0.41246**
44	**56**	.58766	**.38696**	.59712	**.39548**	.60641	**.40402**	.61553	**.41260**
48	**57**	.58782	**.38710**	.59728	**.39562**	.60656	**.40417**	.61568	**.41275**
52	**58**	.58798	**.38724**	.59743	**.39576**	.60671	**.40431**	.61583	**.41289**
56	**59**	.58814	**.38738**	.59759	**.39590**	.60687	**.40445**	.61598	**.41303**
60	**60**	9.58830	**0.38752**	9.59774	**0.39604**	9.60702	**0.40460**	9.61614	**0.41318**

s	′	$5^h 20^m$ Hav.	80° No.	$5^h 24^m$ Hav.	81° No.	$5^h 28^m$ Hav.	82° No.	$5^h 32^m$ Hav.	83° No.
0	0	9.61614	0.41318	9.62509	0.42178	9.63389	0.43041	9.64253	0.43907
4	1	.61629	.41332	.62524	.42193	.63403	.43056	.64267	.43921
8	2	.61644	.41346	.62538	.42207	.63418	.43070	.64281	.43935
12	3	.61659	.41361	.62553	.42221	.63432	.43085	.64296	.43950
16	4	.61674	.41375	.62568	.42236	.63447	.43099	.64310	.43964
20	5	9.61689	0.41389	9.62583	0.42250	9.63461	0.43113	0.64324	0.43979
24	6	.61704	.41404	.62598	.42264	.63476	.43128	.64339	.43993
28	7	.61719	.41418	.62612	.42279	.63490	.43142	.64353	.44008
32	8	.61734	.41432	.62627	.42293	.63505	.43157	.64367	.44022
36	9	.61749	.41447	.62642	.42308	.63519	.43171	.64381	.44036
40	10	9.61764	0.41461	9.62657	0.42322	9.63534	0.43185	9.64396	0.44051
44	11	.61779	.41475	.62671	.42336	.63548	.43200	.64410	.44065
48	12	.61794	.41490	.62686	.42351	.63563	.43214	.64424	.44080
52	13	.61809	.41504	.62701	.42365	.63577	.43229	.64438	.44094
56	14	.61824	.41518	.62716	.42379	.63592	.43243	.64452	.44109

s	′	$5^h 21^m$	80°	$5^h 25^m$	81°	$5^h 29^m$	82°	$5^h 33^m$	83°
0	15	9.61839	0.41533	9.62730	0.42394	9.63606	0.43257	9.64467	0.44123
4	16	.61854	.41547	.62745	.42408	.63621	.43272	.64481	.44138
8	17	.61869	.41561	.62760	.42423	.63635	.43286	.64495	.44152
12	18	.61884	.41576	.62774	.42437	.63649	.43301	.64509	.44166
16	19	.61899	.41590	.62789	.42451	.63664	.43315	.64523	.44181
20	20	9.61914	0.41604	9.62804	0.42466	9.63678	0.43330	9.64538	0.44195
24	21	.61929	.41619	.62819	.42480	.63693	.43344	.64552	.44210
28	22	.61944	.41633	.62833	.42494	.63707	.43358	.64566	.44224
32	23	.61959	.41647	.62848	.42509	.63722	.43373	.64580	.44239
36	24	.61974	.41662	.62863	.42523	.63736	.43387	.64594	.44253
40	25	9.61989	0.41676	9.62877	0.42538	9.63751	0.43402	9.64609	0.44268
44	26	.62003	.41690	.62892	.42552	.63765	.43416	.64623	.44282
48	27	.62018	.41705	.62907	.42566	.63779	.43430	.64637	.44296
52	28	.62033	.41719	.62921	.42581	.63794	.43445	.64651	.44311
56	29	.62048	.41733	.62936	.42595	.63808	.43459	.64665	.44325

s	′	$5^h 22^m$	80°	$5^h 26^m$	81°	$5^h 30^m$	82°	$5^h 34^m$	83°
0	30	9.62063	0.41748	9.62951	0.42610	9.63823	0.43474	9.64679	0.44340
4	31	.62078	.41762	.62965	.42624	.63837	.43488	.64694	.44354
8	32	.62093	.41776	.62980	.42638	.63851	.43503	.64708	.44369
12	33	.62108	.41791	.62995	.42653	.63866	.43517	.64722	.44383
16	34	.62123	.41805	.63009	.42667	.63880	.43531	.64736	.44398
20	35	9.62138	0.41819	9.63024	0.42681	9.63895	0.43546	9.64750	0.44412
24	36	.62153	.41834	.63039	.42696	.63909	.43560	.64764	.44427
28	37	.62168	.41848	.63063	.42710	.63923	.43575	.64778	.44441
32	38	.62182	.41862	.63068	.42725	.63938	.43589	.64793	.44455
36	39	.62197	.41877	.63082	.42739	.63952	.43603	.64807	.44470
40	40	9.62212	0.41891	9.63097	0.42753	9.63966	0.43618	9.64821	0.44484
44	41	.62227	.41905	.63112	.42768	.63981	.43632	.64835	.44499
48	42	.62242	.41920	.63126	.42782	.63995	.43647	.64849	.44513
52	43	.62257	.41934	.63141	.42797	.64010	.43661	.64863	.44528
56	44	.62272	.41949	.63156	.42811	.64024	.43676	.64877	.44542

s	′	$5^h 23^m$	80°	$5^h 27^m$	81°	$5^h 31^m$	82°	$5^h 35^m$	83°
0	45	9.62287	0.41963	9.63170	0.42825	9.64038	0.43690	9.64891	0.44557
4	46	.62301	.41977	.63185	.42840	.64053	.43704	.64905	.44571
8	47	.62316	.41992	.63199	.42854	.64067	.43719	.64919	.44586
12	48	.62331	.42006	.63214	.42869	.64081	.43733	.64934	.44600
16	49	.62346	.42020	.63228	.42883	.64096	.43748	.64948	.44614
20	50	9.62361	0.42035	9.63243	0.42897	9.64110	0.43762	9.64962	0.44629
24	51	.62376	.42049	.63258	.42912	.64124	.43777	.64976	.44643
28	52	.62390	.42063	.63272	.42926	.64139	.43791	.64990	.44658
32	53	.62405	.42078	.63287	.42941	.64153	.43805	.65004	.44672
36	54	.62420	.42092	.63301	.42955	.64167	.43820	.65018	.44687
40	55	9.62435	0.42106	9.63316	0.42969	9.64181	0.43834	9.65032	0.44701
44	56	.62450	.42121	.63330	.42984	.64196	.43849	.65046	.44716
48	57	.62464	.42135	.63345	.42998	.64210	.43863	.65060	.44730
52	58	.62479	.42150	.63360	.43013	.64224	.43878	.65074	.44745
56	59	.62494	.42164	.63374	.43027	.64239	.43892	.65088	.44759
60	60	9.62509	0.42178	9.63389	0.43041	9.64253	0.43907	9.65102	0.44774

s	′	$5^h\ 36^m$	84°	$5^h\ 40^m$	85°	$5^h\ 44^m$	86°	$5^h\ 48^m$	87°
		Hav.	**No.**	**Hav.**	**No.**	**Hav.**	**No.**	**Hav.**	**No.**
0	**0**	9.65102	**0.44774**	9.65937	**0.45642**	9.66757	**0.46512**	9.67562	**0.47383**
4	**1**	.65116	**.44788**	.65950	**.45657**	.66770	**.46527**	.67576	**.47398**
8	**2**	.65130	**.44803**	.65964	**.45671**	.66784	**.46541**	.67589	**.47412**
12	**3**	.65144	**.44817**	.65978	**.45686**	.66797	**.46556**	.67602	**.47427**
16	**4**	.65158	**.44831**	.65992	**.45700**	.66811	**.46570**	.67616	**.47441**
20	**5**	9.65172	**0.44846**	9.66006	**0.45715**	9.66824	**0.46585**	9.67629	**0.47456**
24	**6**	.65186	**.44860**	.66019	**.45729**	.66838	**.46599**	.67642	**.47470**
28	**7**	.65200	**.44875**	.66033	**.45744**	.66851	**.46614**	.67656	**.47485**
32	**8**	.65214	**.44889**	.66047	**.45758**	.66865	**.46628**	.67669	**.47499**
36	**9**	.65228	**.44904**	.66061	**.45773**	.66878	**.46643**	.67682	**.47514**
40	**10**	9.65242	**0.44918**	9.66074	**0.45787**	9.66892	**0.46657**	9.67695	**0.47528**
44	**11**	.65256	**.44933**	.66088	**.45802**	.66905	**.46672**	.67709	**.47543**
48	**12**	.65270	**.44947**	.66102	**.45816**	.66919	**.46686**	.67722	**.47558**
52	**13**	.65284	**.44962**	.66116	**.45831**	.66932	**.46701**	.67735	**.47572**
56	**14**	.65298	**.44976**	.66129	**.45845**	.66946	**.46715**	.67748	**.47587**
s	′	$5^h\ 37^m$	84°	$5^h\ 41^m$	85°	$5^h\ 45^m$	86°	$5^h\ 49^m$	87°
0	**15**	9.65312	**0.44991**	9.66143	**0.45860**	9.66959	**0.46730**	9.67762	**0.47601**
4	**16**	.65326	**.45005**	.66157	**.45874**	.66973	**.46744**	.67775	**.47616**
8	**17**	.65340	**.45020**	.66170	**.45889**	.66986	**.46759**	.67788	**.47630**
12	**18**	.65354	**.45034**	.66184	**.45903**	.67000	**.46773**	.67801	**.47645**
16	**19**	.65368	**.45048**	.66198	**.45918**	.67013	**.46788**	.67815	**.47659**
20	**20**	9.65382	**0.45063**	9.66212	**0.45932**	9.67027	**0.46802**	9.67828	**0.47674**
24	**21**	.65396	**.45077**	.66225	**.45947**	.67040	**.46817**	.67841	**.47688**
28	**22**	.65410	**.45092**	.66239	**.45961**	.67054	**.46831**	.67854	**.47703**
32	**23**	.65424	**.45106**	.66253	**.45976**	.67067	**.46846**	.67868	**.47717**
36	**24**	.65438	**.45121**	.66266	**.45990**	.67081	**.46860**	.67881	**.47732**
40	**25**	9.65452	**0.45135**	9.66280	**0.46005**	9.67094	**0.46875**	9.67894	**0.47746**
44	**26**	.65466	**.45150**	.66294	**.46019**	.67108	**.46890**	.67907	**.47761**
48	**27**	.65480	**.45164**	.66307	**.46034**	.67121	**.46904**	.67920	**.47775**
52	**28**	.65493	**.45179**	.66321	**.46048**	.67134	**.46919**	.67934	**.47790**
56	**29**	.65507	**.45193**	.66335	**.46063**	.67148	**.46933**	.67947	**.47805**
s	′	$5^h\ 38^m$	84°	$5^h\ 42^m$	85°	$5^h\ 46^m$	86°	$5^h\ 50^m$	87°
0	**30**	9.65521	**0.45208**	9.66348	**0.46077**	9.67161	**0.46948**	9.67960	**0.47819**
4	**31**	.65535	**.45222**	.66362	**.46092**	.67175	**.46962**	.67973	**.47834**
8	**32**	.65549	**.45237**	.66376	**.46106**	.67188	**.46977**	.67986	**.47848**
12	**33**	.65563	**.45251**	.66389	**.46121**	.67202	**.46991**	.68000	**.47863**
16	**34**	.65577	**.45266**	.66403	**.46135**	.67215	**.47006**	.68013	**.47877**
20	**35**	9.65591	**0.45280**	9.66417	**0.46150**	9.67228	**0.47020**	9.68026	**0.47892**
24	**36**	.65605	**.45295**	.66430	**.46164**	.67242	**.47035**	.68039	**.47906**
28	**37**	.65619	**.45309**	.66444	**.46179**	.67255	**.47049**	.68052	**.47921**
32	**38**	.65632	**.45324**	.66458	**.46193**	.67269	**.47064**	.68066	**.47935**
36	**39**	.65646	**.45338**	.66471	**.46208**	.67282	**.47078**	.68079	**.47950**
40	**40**	9.65660	**0.45353**	9.66485	**0.46222**	9.67295	**0.47093**	9.68092	**0.47964**
44	**41**	.65674	**.45367**	.66499	**.46237**	.67309	**.47107**	.68105	**.47979**
48	**42**	.65688	**.45381**	.66512	**.46251**	.67322	**.47122**	.68118	**.47993**
52	**43**	.65702	**.45396**	.66526	**.46266**	.67336	**.47136**	.68131	**.48008**
56	**44**	.65716	**.45410**	.66539	**.46280**	.67349	**.47151**	.68144	**.48022**
s	′	$5^h\ 39^m$	84°	$5^h\ 43^m$	85°	$5^h\ 47^m$	86°	$5^h\ 51^m$	87°
0	**45**	9.65729	**0.45425**	9.66553	**0.46295**	9.67362	**0.47165**	9.68158	**0.48037**
4	**46**	.65743	**.45439**	.66567	**.46309**	.67376	**.47180**	.68171	**.48052**
8	**47**	.65757	**.45454**	.66580	**.46324**	.67389	**.47194**	.68184	**.48066**
12	**48**	.65771	**.45468**	.66594	**.46338**	.67402	**.47209**	.68197	**.48081**
16	**49**	.65785	**.45483**	.66607	**.46353**	.67416	**.47223**	.68210	**.48095**
20	**50**	9.65799	**0.45497**	9.66621	**0.46367**	9.67429	**0.47238**	9.68223	**0.48110**
24	**51**	.65812	**.45512**	.66635	**.46382**	.67443	**.47252**	.68236	**.48124**
28	**52**	.65826	**.45526**	.66648	**.46396**	.67456	**.47267**	.68249	**.48139**
32	**53**	.65840	**.45541**	.66662	**.46411**	.67469	**.47282**	.68263	**.48153**
36	**54**	.65854	**.45555**	.66675	**.46425**	.67483	**.47296**	.68276	**.48168**
40	**55**	9.65868	**0.45570**	9.66689	**0.46440**	9.67496	**0.47311**	9.68289	**0.48182**
44	**56**	.65881	**.45584**	.66702	**.46454**	.67509	**.47325**	.68302	**.48197**
48	**57**	.65895	**.45599**	.66716	**.46469**	.67522	**.47340**	.68315	**.48211**
52	**58**	.65909	**.45613**	.66730	**.46483**	.67536	**.47354**	.68328	**.48226**
56	**59**	.65923	**.45628**	.66743	**.46498**	.67549	**.47369**	.68341	**.48241**
60	**60**	9.65937	**0.45642**	9.66757	**0.46512**	9.67562	**0.47383**	9.68354	**0.48255**

Table 10. Haversine Table

s	′	$5^h 52^m$	88°	$5^h 56^m$	89°	s	$6^h 0^m$	$6^h 4^m$
		Hav.	No.	Hav.	No.		Hav.	Hav.
0	0	9.68354	**0.48255**	9.69132	**0.49127**	0	9.69897	9.70648
4	1	.68367	**.48269**	.69145	**.49142**	4	.69910	.70661
8	2	.68380	**.48284**	.69158	**.49156**	8	.69922	.70673
12	3	.68393	**.48299**	.69171	**.49171**	12	.69935	.70686
16	4	.68407	**.48313**	.69184	**.49186**	16	.69948	.70698
20	5	9.68420	**0.48328**	9.69197	**0.49200**	20	9.69960	9.70710
24	6	.68433	**.48342**	.69209	**.49215**	24	.69973	.70723
28	7	.68446	**.48357**	.69222	**.49229**	28	.69985	.70735
32	8	.68459	**.48371**	.69235	**.49244**	32	.69998	.70748
36	9	.68472	**.48386**	.69248	**.49258**	36	.70011	.70760
40	10	9.68485	**0.48400**	9.69261	**0.49273**	40	9.70023	9.70772
44	11	.68498	**.48415**	.69274	**.49287**	44	.70036	.70785
48	12	.68511	**.48429**	.69286	**.49302**	48	.70048	.70797
52	13	.68524	**.48444**	.69299	**.49316**	52	.70061	.70809
56	14	.68537	**.48459**	.69312	**.49331**	56	.70074	.70822
s	′	$5^h 53^m$	88°	$5^h 57^m$	89°	s	$6^h 1^m$	$6^h 5^m$
0	15	9.68550	**0.48473**	9.69325	**0.49346**	0	9.70086	9.70834
4	16	.68563	**.48488**	.69338	**.49360**	4	.70099	.70847
8	17	.68576	**.48502**	.69350	**.49375**	8	.70111	.70859
12	18	.68589	**.48517**	.69363	**.49389**	12	.70124	.70871
16	19	.68602	**.48531**	.69376	**.49404**	16	.70136	.70884
20	20	9.68615	**0.48546**	9.69389	**0.49418**	20	9.70149	9.70896
24	21	.68628	**.48560**	.69402	**.49433**	24	.70161	.70908
28	22	.68641	**.48575**	.69414	**.49447**	28	.70174	.70921
32	23	.68654	**.48589**	.69427	**.49462**	32	.70187	.70933
36	24	.68667	**.48604**	.69440	**.49476**	36	.70199	.70945
40	25	9.68680	**0.48618**	9.69453	**0.49491**	40	9.70212	9.70958
44	26	.68693	**.48633**	.69465	**.49506**	44	.70224	.70970
48	27	.68706	**.48648**	.69478	**.49520**	48	.70237	.70982
52	28	.68719	**.48662**	.69491	**.49535**	52	.70249	.70995
56	29	.68732	**.48677**	.69504	**.49549**	56	.70262	.71007
s	′	$5^h 54^m$	88°	$5^h 58^m$	89°	s	$6^h 2^m$	$6^h 6^m$
0	30	9.68745	**0.48691**	9.69516	**0.49564**	0	9.70274	9.71019
4	31	.68758	**.48706**	.69529	**.49578**	4	.70287	.71032
8	32	.68771	**.48720**	.69542	**.49593**	8	.70299	.71044
12	33	.68784	**.48735**	.69555	**.49607**	12	.70312	.71056
16	34	.68797	**.48749**	.69567	**.49622**	16	.70324	.71068
20	35	9.68810	**0.48764**	9.69580	**0.49636**	20	9.70337	9.71081
24	36	.68823	**.48778**	.69593	**.49651**	24	.70349	.71093
28	37	.68836	**.48793**	.69605	**.49665**	28	.70362	.71105
32	38	.68849	**.48807**	.69618	**.49680**	32	.70374	.71118
36	39	.68862	**.48822**	.69631	**.49695**	36	.70387	.71130
40	40	9.68875	**0.48837**	9.69644	**0.49709**	40	9.70399	9.71142
44	41	.68887	**.48851**	.69656	**.49724**	44	.70412	.71154
48	42	.68900	**.48866**	.69669	**.49738**	48	.70424	.71167
52	43	.68913	**.48880**	.69682	**.49753**	52	.70437	.71179
56	44	.68926	**.48895**	.69694	**.49767**	56	.70449	.71191
s	′	$5^h 55^m$	88°	$5^h 59^m$	89°	s	$6^h 3^m$	$6^h 7^m$
0	45	9.68939	**0.48909**	9.69707	**0.49782**	0	9.70462	9.71203
4	46	.68952	**.48924**	.69720	**.49796**	4	.70474	.71216
8	47	.68965	**.48938**	.69732	**.49811**	8	.70487	.71228
12	48	.68978	**.48953**	.69745	**.49825**	12	.70499	.71240
16	49	.68991	**.48967**	.69758	**.49840**	16	.70512	.71252
20	50	9.69004	**0.48982**	9.69770	**0.49855**	20	9.70524	9.71265
24	51	.69017	**.48997**	.69783	**.49869**	24	.70537	.71277
28	52	.69029	**.49011**	.69796	**.49884**	28	.70549	.71289
32	53	.69042	**.49026**	.69808	**.49898**	32	.70561	.71301
36	54	.69055	**.49040**	.69821	**.49913**	36	.70574	.71314
40	55	9.69068	**0.49055**	9.69834	**0.49927**	40	9.70586	9.71326
44	56	.69081	**.49069**	.69846	**.49942**	44	.70599	.71338
48	57	.69094	**.49084**	.69859	**.49956**	48	.70611	.71350
52	58	.69107	**.49098**	.69872	**.49971**	52	.70624	.71362
56	59	.69120	**.49113**	.69884	**.49985**	56	.70636	.71375
60	60	9.69132	**0.49127**	9.69897	**0.50000**	60	9.70648	9.71387

Note.—The **No.** column is omitted in the rest of this table, as the No. haversines are not needed beyond 6^h or **90°**.

s	$6^h\,8^m$	$6^h\,12^m$	$6^h\,16^m$	$6^h\,20^m$	$6^h\,24^m$	$6^h\,28^m$	$6^h\,32^m$	$6^h\,36^m$
	Hav.	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**
0	9.71387	9.72112	9.72825	9.73526	9.74215	9.74891	9.75556	9.76209
4	.71399	.72124	.72837	.73538	.74226	.74902	.75567	.76220
8	.71411	.72136	.72849	.73549	.74237	.74914	.75578	.76231
12	.71423	.72148	.72861	.73561	.74249	.74925	.75589	.76241
16	.71436	.72160	.72873	.73572	.74260	.74936	.75600	.76252
20	9.71448	9.72172	9.72884	9.73584	9.74272	9.74947	9.75611	9.76263
24	.71460	.72184	.72896	.73596	.74283	.74958	.75622	.76274
28	.71472	.72196	.72908	.73607	.74294	.74969	.75633	.76285
32	.71484	.72208	.72920	.73619	.74306	.74981	.75644	.76296
36	.71496	.72220	.72931	.73630	.74317	.74992	.75655	.76306
40	9.71509	9.72232	9.72943	9.73642	9.74328	9.75003	9.75666	9.76317
44	.71521	.72244	.72955	.73653	.74340	.75014	.75677	.76328
48	.71533	.72256	.72967	.73665	.74351	.75025	.75688	.76338
52	.71545	.72268	.72978	.73676	.74362	.75036	.75698	.76349
56	.71557	.72280	.72990	.73688	.74374	.75047	.75709	.76360
s	$6^h\,9^m$	$6^h\,13^m$	$6^h\,17^m$	$6^h\,21^m$	$6^h\,25^m$	$6^h\,29^m$	$6^h\,33^m$	$6^h\,37^m$
0	9.71569	9.72292	9.73002	9.73699	9.74385	9.75059	9.75720	9.76371
4	.71582	.72304	.73014	.73711	.74396	.75070	.75731	.76381
8	.71594	.72316	.73025	.73722	.74408	.75081	.75742	.76392
12	.71606	.72328	.73037	.73734	.74419	.75092	.75753	.76403
16	.71618	.72340	.73049	.73746	.74430	.75103	.75764	.76414
20	9.71630	9.72352	9.73060	9.73757	9.74442	9.75114	9.75775	9.76424
24	.71642	.72363	.73072	.73769	.74453	.75125	.75786	.76435
28	.71654	.72375	.73084	.73780	.74464	.75136	.75797	.76446
32	.71666	.72387	.73096	.73792	.74475	.75147	.75808	.76456
36	.71679	.72399	.73107	.73803	.74487	.75159	.75819	.76467
40	9.71691	9.72411	9.73119	9.73815	9.74498	9.75170	9.75830	9.76478
44	.71703	.72423	.73131	.73826	.74509	.75181	.75840	.76489
48	.71715	.72435	.73142	.73838	.74521	.75192	.75851	.76499
52	.71727	.72447	.73154	.73849	.74532	.75203	.75862	.76510
56	.71739	.72459	.73166	.73860	.74543	.75214	.75873	.76521
s	$6^h\,10^m$	$6^h\,14^m$	$6^h\,18^m$	$6^h\,22^m$	$6^h\,26^m$	$6^h\,30^m$	$6^h\,34^m$	$6^h\,38^m$
0	9.71751	9.72471	9.73177	9.73872	9.74554	9.75225	9.75884	9.76531
4	.71763	.72482	.73189	.73883	.74566	.75236	.75895	.76542
8	.71775	.72494	.73201	.73895	.74577	.75247	.75906	.76553
12	.71787	.72506	.73212	.73906	.74588	.75258	.75917	.76563
16	.71800	.72518	.73224	.73918	.74600	.75269	.75927	.76574
20	9.71812	9.72530	9.73236	9.73929	9.74611	9.75280	9.75938	9.76585
24	.71824	.72542	.73247	.73941	.74622	.75291	.75949	.76595
28	.71836	.72554	.73259	.73952	.74633	.75303	.75960	.76606
32	.71848	.72565	.73271	.73964	.74645	.75314	.75971	.76617
36	.71860	.72577	.73282	.73975	.74656	.75325	.75982	.76627
40	9.71872	9.72589	9.73294	9.73987	9.74667	9.75336	9.75993	9.76638
44	.71884	.72601	.73306	.73998	.74678	.75347	.76004	.76649
48	.71896	.72613	.73317	.74009	.74690	.75358	.76014	.76659
52	.71908	.72625	.73329	.74021	.74701	.75369	.76025	.76670
56	.71920	.72637	.73341	.74032	.74712	.75380	.76036	.76681
s	$6^h\,11^m$	$6^h\,15^m$	$6^h\,19^m$	$6^h\,23^m$	$6^h\,27^m$	$6^h\,31^m$	$6^h\,35^m$	$6^h\,39^m$
0	9.71932	9.72648	9.73352	9.74044	9.74723	9.75391	9.76047	9.76691
4	.71944	.72660	.73364	.74055	.74734	.75402	.76058	.76702
8	.71956	.72672	.73375	.74067	.74746	.75413	.76069	.76713
12	.71968	.72684	.73387	.74078	.74757	.75424	.76079	.76723
16	.71980	.72696	.73399	.74089	.74768	.75435	.76090	.76734
20	9.71992	9.72708	9.73410	9.74101	9.74779	9.75446	9.76101	9.76745
24	.72004	.72719	.73422	.74112	.74791	.75457	.76112	.76755
28	.72016	.72731	.73433	.74124	.74802	.75468	.76123	.76766
32	.72028	.72743	.73445	.74135	.74813	.75479	.76134	.76777
36	.72040	.72755	.73457	.74146	.74824	.75490	.76144	.76787
40	9.72052	9.72767	9.73468	9.74158	9.74835	9.75501	9.76155	9.76798
44	.72064	.72778	.73480	.74169	.74846	.75512	.76166	.76808
48	.72076	.72790	.73491	.74181	.74858	.75523	.76177	.76819
52	.72088	.72802	.73503	.74192	.74869	.75534	.76188	.76830
56	.72100	.72814	.73515	.74203	.74880	.75545	.76198	.76840
60	9.72112	9.72825	9.73526	9.74215	9.74891	9.75556	9.76209	9.76851

s	$6^h\ 40^m$	$6^h\ 44^m$	$6^h\ 48^m$	$6^h\ 52^m$	$6^h\ 56^m$	$7^h\ 0^m$	$7^h\ 4^m$	$7^h\ 8^m$
	Hav.	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**
0	9.76851	9.77481	9.78101	9.78709	9.79306	9.79893	9.80470	9.81036
4	.76861	.77492	.78111	.78719	.79316	.79903	.80479	.81045
8	.76872	.77502	.78121	.78729	.79326	.79913	.80489	.81054
12	.76883	.77512	.78131	.78739	.79336	.79922	.80498	.81064
16	.76893	.77523	.78141	.78749	.79346	.79932	.80508	.81073
20	9.76904	9.77533	9.78152	9.78759	9.79356	9.79942	9.80517	9.81082
24	.76914	.77544	.78162	.78769	.79366	.79951	.80527	.81092
28	.76925	.77554	.78172	.78779	.79376	.79961	.80536	.81101
32	.76936	.77564	.78182	.78789	.79385	.79971	.80546	.81110
36	.76946	.77575	.78192	.78799	.79395	.79980	.80555	.81120
40	9.76957	9.77585	9.78203	9.78809	9.79405	9.79990	9.80565	9.88129
44	.76967	.77596	.78213	.78819	.79415	.80000	.80574	.81138
48	.76978	.77606	.78223	.78829	.79425	.80009	.80584	.81148
52	.76988	.77616	.78233	.78839	.79434	.80019	.80593	.81157
56	.76999	.77627	.78243	.78849	.79444	.80029	.80603	.81166
s	$6^h\ 41^m$	$6^h\ 45^m$	$6^h\ 49^m$	$6^h\ 53^m$	$6^h\ 57^m$	$7^h\ 1^m$	$7^h\ 5^m$	$7^h\ 9^m$
0	9.77009	9.77637	9.78254	9.78859	9.79454	9.80038	9.80612	9.81176
4	.77020	.77647	.78264	.78869	.79464	.80048	.80622	.81185
8	.77031	.77658	.78274	.78879	.79474	.80058	.80631	.81194
12	.77041	.77668	.78284	.78889	.79484	.80067	.80641	.81204
16	.77052	.77679	.78294	.78899	.79493	.80077	.80650	.81213
20	9.77062	9.77689	9.78305	9.78909	9.79503	9.80087	9.80660	9.81222
24	.77073	.77699	.78315	.78919	.79513	.80096	.80669	.81231
28	.77083	.77710	.78325	.78929	.79523	.80106	.80678	.81241
32	.77094	.77720	.78335	.78939	.79533	.80116	.80688	.81250
36	.77104	.77730	.78345	.78949	.79542	.80125	.80697	.81259
40	9.77115	9.77741	9.78355	9.78959	9.79552	9.80135	9.80707	9.81269
44	.77125	.77751	.78365	.78969	.79562	.80144	.80716	.81278
48	.77136	.77761	.78376	.78979	.79572	.80154	.80726	.81287
52	.77146	.77772	.78386	.78989	.79582	.80164	.80735	.81296
56	.77157	.77782	.78396	.78999	.79591	.80173	.80745	.81306
s	$6^h\ 42^m$	$6^h\ 46^m$	$6^h\ 50^m$	$6^h\ 54^m$	$6^h\ 58^m$	$7^h\ 2^m$	$7^h\ 6^m$	$7^h\ 10^m$
0	9.77167	9.77792	9.78406	9.79009	9.79601	9.80183	9.80754	9.81315
4	.77178	.77803	.78416	.79019	.79611	.80192	.80763	.81324
8	.77188	.77813	.78426	.79029	.79621	.80202	.80773	.81333
12	.77199	.77823	.78436	.79039	.79631	.80212	.80782	.81343
16	.77209	.77834	.78447	.79049	.79640	.80221	.80792	.81352
20	9.77220	9.77844	9.78457	9.79059	9.79650	9.80231	9.80801	9.81361
24	.77230	.77854	.78467	.79069	.79660	.80240	.80811	.81370
28	.77241	.77864	.78477	.79079	.79670	.80250	.80820	.81380
32	.77251	.77875	.78487	.79089	.79679	.80260	.80829	.81389
36	.77262	.77885	.78497	.79099	.79689	.80269	.80839	.81398
40	9.77272	9.77895	9.78507	9.79108	9.79699	9.80279	9.80848	9.81407
44	.77283	.77906	.78517	.79118	.79709	.80288	.80858	.81417
48	.77293	.77916	.78528	.79128	.79718	.80298	.80867	.81426
52	.77304	.77926	.78538	.79138	.79728	.80307	.80876	.81435
56	.77314	.77936	.78548	.79148	.79738	.80317	.80886	.81444
s	$6^h\ 43^m$	$6^h\ 47^m$	$6^h\ 51^m$	$6^h\ 55^m$	$6^h\ 59^m$	$7^h\ 3^m$	$7^h\ 7^m$	$7^h\ 11^m$
0	9.77325	9.77947	9.78558	9.79158	9.79748	9.80327	9.80895	9.81454
4	.77335	.77957	.78568	.79168	.79757	.80336	.80905	.81463
8	.77346	.77967	.78578	.79178	.79767	.80346	.80914	.81472
12	.77356	.77978	.78588	.79188	.79777	.80355	.80923	.81481
16	.77366	.77988	.78598	.79198	.79787	.80365	.80933	.81490
20	9.77377	9.77998	9.78608	9.79208	9.79796	9.80374	9.80942	9.81500
24	.77387	.78008	.78618	.79217	.79806	.80384	.80952	.81509
28	.77398	.78019	.78628	.79227	.79816	.80393	.80961	.81518
32	.77408	.78029	.78638	.79237	.79825	.80403	.80970	.81527
36	.77419	.78039	.78649	.79247	.79835	.80413	.80980	.81536
40	9.77429	9.78049	9.78659	9.79257	9.79845	9.80422	9.80989	9.81546
44	.77440	.78060	.78669	.79267	.79855	.80432	.80998	.81555
48	.77450	.78070	.78679	.79277	.79864	.80441	.81008	.81564
52	.77460	.78080	.78689	.79287	.79874	.80451	.81017	.81573
56	.77471	.78090	.78699	.79297	.79884	.80460	.81026	.81582
60	9.77481	9.78101	9.78709	9.79306	9.79893	9.80470	9.81036	9.81592

s	$7^h\ 12^m$	$7^h\ 16^m$	$7^h\ 20^m$	$7^h\ 24^m$	$7^h\ 28^m$	$7^h\ 32^m$	$7^h\ 36^m$	$7^h\ 40^m$
	Hav.	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**
0	9.81592	9.82137	9.82673	9.83199	9.83715	9.84221	9.84718	9.85206
4	.81601	.82146	.82682	.83207	.83723	.84230	.84726	.85214
8	.81610	.82155	.82691	.83216	.83732	.84238	.84735	.85222
12	.81619	.82164	.82699	.83225	.83740	.84246	.84743	.85230
16	.81628	.82173	.82708	.83233	.83749	.84255	.84751	.85238
20	9.81637	9.82182	9.82717	9.83242	9.83757	9.84263	9.84759	9.85246
24	.81647	.82191	.82726	.83251	.83766	.84271	.84767	.85254
28	.81656	.82200	.82735	.83259	.83774	.84280	.84776	.85262
32	.81665	.82209	.82744	.83268	.83783	.84288	.84784	.85270
36	.81674	.82218	.82752	.83277	.83791	.84296	.84792	.85278
40	9.81683	9.82227	9.82761	9.83285	9.83800	9.84305	9.84800	9.85286
44	.81692	.82236	.82770	.83294	.83808	.84313	.84808	.85294
48	.81701	.82245	.82779	.83303	.83817	.84321	.84817	.85302
52	.81711	.82254	.82788	.83311	.83825	.84330	.84825	.85310
56	.81720	.82263	.82796	.83320	.83834	.84338	.84833	.85318
s	$7^h\ 13^m$	$7^h\ 17^m$	$7^h\ 21^m$	$7^h\ 25^m$	$7^h\ 29^m$	$7^h\ 33^m$	$7^h\ 37^m$	$7^h\ 41^m$
0	9.81729	9.82272	9.82805	9.83329	9.83842	9.84346	9.84841	9.85326
4	.81738	.82281	.82814	.83337	.83851	.84355	.84849	.85334
8	.81747	.82290	.82823	.83346	.83859	.84363	.84857	.85342
12	.81756	.82299	.82832	.83355	.83868	.84371	.84866	.85350
16	.81765	.82308	.82840	.83363	.83876	.84380	.84874	.85358
20	9.81775	9.82317	9.82849	9.83372	9.83885	9.84388	9.84882	9.85366
24	.81784	.82326	.82858	.83380	.83893	.84396	.84890	.85374
28	.81793	.82335	.82867	.83389	.83902	.84405	.84898	.85382
32	.81802	.82344	.82876	.83398	.83910	.84413	.84906	.85390
36	.81811	.82353	.82884	.83406	.83919	.84421	.84914	.85398
40	9.81820	9.82362	9.82893	9.83415	9.83927	9.84430	9.84923	9.85406
44	.81829	.82371	.82902	.83424	.83935	.84438	.84931	.85414
48	.81838	.82380	.82911	.83432	.83944	.84446	.84939	.85422
52	.81847	.82388	.82920	.83441	.83952	.84454	.84947	.85430
56	.81857	.82397	.82928	.83449	.83961	.84463	.84955	.85438
s	$7^h\ 14^m$	$7^h\ 18^m$	$7^h\ 22^m$	$7^h\ 26^m$	$7^h\ 30^m$	$7^h\ 34^m$	$7^h\ 38^m$	$7^h\ 42^m$
0	9.81866	9.82406	9.82937	9.83458	9.83969	9.84471	9.84963	9.85446
4	.81875	.82415	.82946	.83467	.83978	.84479	.84971	.85454
8	.81884	.82424	.82955	.83475	.83986	.84488	.84979	.85462
12	.81893	.82433	.82963	.83484	.83995	.84496	.84988	.85470
16	.81902	.82442	.82972	.83492	.84003	.84504	.84996	.85478
20	9.81911	9.82451	9.82981	9.83501	9.84011	9.84512	9.85004	9.85486
24	.81920	.82460	.82990	.83510	.84020	.84521	.85012	.85494
28	.81929	.82469	.82998	.83518	.84028	.84529	.85020	.85502
32	.81938	.82478	.83007	.83527	.84037	.84537	.85028	.85510
36	.81947	.82487	.83016	.83535	.84045	.84545	.85036	.85518
40	9.81956	9.82495	9.83025	9.83544	9.84054	9.84554	9.85044	9.85526
44	.81965	.82504	.83033	.83552	.84062	.84562	.85052	.85534
48	.81975	.82513	.83042	.83561	.84070	.84570	.85061	.85542
52	.81984	.82522	.83051	.83570	.84079	.84578	.85069	.85550
56	.81993	.82531	.83059	.83578	.84087	.84587	.85077	.85557
s	$7^h\ 15^m$	$7^h\ 19^m$	$7^h\ 23^m$	$7^h\ 27^m$	$7^h\ 31^m$	$7^h\ 35^m$	$7^h\ 39^m$	$7^h\ 43^m$
0	9.82002	9.82540	9.83068	9.83587	9.84096	9.84595	9.85085	9.85565
4	.82011	.82549	.83077	.83595	.84104	.84603	.85093	.85573
8	.82020	.82558	.83086	.83604	.84112	.84611	.85101	.85581
12	.82029	.82567	.83094	.83612	.84121	.84620	.85109	.85589
16	.82038	.82575	.83103	.83621	.84129	.84628	.85117	.85597
20	9.82047	9.82584	9.83112	9.83630	9.84138	9.84636	9.85125	9.85605
24	.82056	.82593	.83120	.83638	.84146	.84644	.85133	.85613
28	.82065	.82602	.83129	.83647	.84154	.84653	.85141	.85621
32	.82074	.82611	.83138	.83655	.84163	.84661	.85149	.85629
36	.82083	.82620	.83147	.83664	.84171	.84669	.85158	.85637
40	9.82092	9.82629	9.83155	9.83672	9.84179	9.84677	9.85166	9.85645
44	.82101	.82638	.83164	.83681	.84188	.84685	.85174	.85653
48	.82110	.82646	.83173	.83689	.84196	.84694	.85182	.85660
52	.82119	.82655	.83181	.83698	.84205	.84702	.85190	.85668
56	.82128	.82664	.83190	.83706	.84213	.84710	.85198	.85676
60	9.82137	9.82673	9.83199	9.83715	9.84221	9.84718	9.85206	9.85684

s	$7^h\ 44^m$ Hav.	$7^h\ 48^m$ Hav.	$7^h\ 52^m$ Hav.	$7^h\ 56^m$ Hav.	$8^h\ 0^m$ Hav.	$8^h\ 4^m$ Hav.	$8^h\ 8^m$ Hav.	$8^h\ 12^m$ Hav.
0	9.85684	9.86153	9.86613	9.87064	9.87506	9.87939	9.88364	9.88780
4	.85692	.86161	.86621	.87072	.87513	.87947	.88371	.88787
8	.85700	.86169	.86628	.87079	.87521	.87954	.88378	.88793
12	.85708	.86176	.86636	.87086	.87528	.87961	.88385	.88800
16	.85716	.86184	.86643	.87094	.87535	.87968	.88392	.88807
20	9.85724	9.86192	9.86651	9.87101	9.87543	9.87975	9.88399	9.88814
24	.85731	.86200	.86659	.87109	.87550	.87982	.88406	.88821
28	.85739	.86207	.86666	.87116	.87557	.87989	.88413	.88828
32	.85747	.86215	.86674	.87124	.87564	.87996	.88420	.88835
36	.85755	.86223	.86681	.87131	.87572	.88004	.88427	.88841
40	9.85763	9.86230	9.86689	9.87138	9.87579	9.88011	9.88434	9.88848
44	.85771	.86238	.86696	.87146	.87586	.88018	.88441	.88855
48	.85779	.86246	.86704	.87153	.87593	.88025	.88448	.88862
52	.85787	.86254	.86712	.87161	.87601	.88032	.88455	.88869
56	.85794	.86261	.86719	.87168	.87608	.88039	.88462	.88876
s	$7^h\ 45^m$	$7^h\ 49^m$	$7^h\ 53^m$	$7^h\ 57^m$	$8^h\ 1^m$	$8^h\ 5^m$	$8^h\ 9^m$	$8^h\ 13^m$
0	9.85802	9.86269	9.86727	9.87175	9.87615	9.88046	9.88469	9.88882
4	.85810	.86277	.86734	.87183	.87623	.88053	.88476	.88889
8	.85818	.86284	.86742	.87190	.87630	.88061	.88483	.88896
12	.85826	.86292	.86749	.87198	.87637	.88068	.88490	.88903
16	.85834	.86300	.86757	.87205	.87644	.88075	.88496	.88910
20	9.85841	9.86307	9.86764	9.87212	9.87652	9.88082	9.88503	9.88916
24	.85849	.86315	.86772	.87220	.87659	.88089	.88510	.88923
28	.85857	.86323	.86780	.87227	.87666	.88096	.88517	.88930
32	.85865	.86331	.86787	.87235	.87673	.88103	.88524	.88937
36	.85873	.86338	.86795	.87242	.87680	.88110	.88531	.88944
40	9.85881	9.86346	9.86802	9.87249	9.87688	9.88117	9.88528	9.88950
44	.85888	.86354	.86810	.87257	.87695	.88124	.88545	.88957
48	.85896	.86361	.86817	.87264	.87702	.88131	.88552	.88964
52	.85904	.86369	.86825	.87271	.87709	.88139	.88559	.88971
56	.85912	.86377	.86832	.87279	.87717	.88146	.88566	.88978
s	$7^h\ 46^m$	$7^h\ 50^m$	$7^h\ 54^m$	$7^h\ 58^m$	$8^h\ 2^m$	$8^h\ 6^m$	$8^h\ 10^m$	$8^h\ 14^m$
0	9.85920	9.86384	9.86840	9.87286	9.87724	9.88153	9.88573	9.88984
4	.85928	.86392	.86847	.87294	.87731	.88160	.88580	.88991
8	.85935	.86400	.86855	.87301	.87738	.88167	.88587	.88998
12	.85943	.86407	.86862	.87308	.87745	.88174	.88594	.89005
16	.85951	.86415	.86870	.87316	.87753	.88181	.88600	.89012
20	9.85959	9.86423	9.86877	9.87323	9.87760	9.88188	9.88607	9.89018
24	.85967	.86430	.86885	.87330	.87767	.88195	.88614	.89025
28	.85974	.86438	.86892	.87338	.87774	.88202	.88621	.89032
32	.85982	.86446	.86900	.87345	.87782	.88209	.88628	.89039
36	.85990	.86453	.86907	.87352	.87789	.88216	.88635	.89045
40	9.85998	9.86461	9.86915	9.87360	9.87796	9.88223	9.88642	9.89052
44	.86006	.86468	.86922	.87367	.87803	.88230	.88649	.89059
48	.86013	.86476	.86930	.87374	.87810	.88237	.88656	.89066
52	.86021	.86484	.86937	.87382	.87818	.88244	.88663	.89072
56	.86029	.86491	.86945	.87389	.87825	.88252	.88670	.89079
s	$7^h\ 47^m$	$7^h\ 51^m$	$7^h\ 55^m$	$7^h\ 59^m$	$8^h\ 3^m$	$8^h\ 7^m$	$8^h\ 11^m$	$8^h\ 15^m$
0	9.86037	9.86499	9.86952	9.87396	9.87832	9.88259	9.88677	9.89086
4	.86045	.86507	.86960	.87404	.87839	.88266	.88683	.89093
8	.86052	.86514	.86967	.87411	.87846	.88273	.88690	.89099
12	.86060	.86522	.86975	.87418	.87853	.88280	.88697	.89106
16	.86068	.86529	.86982	.87426	.87861	.88287	.88704	.89113
20	9.86076	9.86537	9.86990	9.87433	9.87868	9.88294	9.88711	9.89120
24	.86083	.86545	.86997	.87440	.87875	.88301	.88718	.89126
28	.86091	.86552	.87004	.87448	.87882	.88308	.88725	.89133
32	.86099	.86560	.87012	.87455	.87889	.88315	.88732	.89140
36	.86107	.86568	.87019	.87462	.87896	.88322	.88739	.89147
40	9.86114	9.86575	9.87027	9.87470	9.87904	9.88329	9.88745	9.89153
44	.86122	.86583	.87034	.87477	.87911	.88336	.88752	.89160
48	.86130	.86590	.87042	.87484	.87918	.88343	.88759	.89167
52	.86138	.86598	.87049	.87492	.87925	.88350	.88766	.89174
56	.86145	.86606	.87057	.87499	.87932	.88357	.88773	.89180
60	9.86153	9.86613	9.87064	9.87506	9.87939	9.88364	9.88780	9.89187

s	8h 16m	8h 20m	8h 24m	8h 28m	8h 32m	8h 36m	8h 40m	8h 44m
	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.
0	9.89187	9.89586	9.89976	9.90358	9.90732	9.91098	9.91455	9.91805
4	.89194	.89592	.89983	.90365	.90738	.91104	.91461	.91810
8	.89200	.89599	.89989	.90371	.90744	.91110	.91467	.91816
12	.89207	.89606	.89995	.90377	.90751	.91116	.91473	.91822
16	.89214	.89612	.90002	.90383	.90757	.91122	.91479	.91828
20	9.89221	9.89619	9.90008	9.90390	9.90763	9.91128	9.91485	9.91833
24	.89227	.89625	.90015	.90396	.90769	.91134	.91490	.91839
28	.89234	.89632	.90021	.90402	.90775	.91140	.91496	.91845
32	.89241	.89638	.90028	.90409	.90781	.91146	.91502	.91851
36	.89247	.89645	.90034	.90415	.90787	.91152	.91508	.91856
40	9.89254	9.89651	9.90040	9.90421	9.90794	9.91158	9.91514	9.91862
44	.89261	.89658	.90047	.90428	.90800	.91164	.91520	.91868
48	.89267	.89665	.90053	.90434	.90806	.91170	.91526	.91874
52	.89274	.89671	.90060	.90440	.90812	.91176	.91532	.91879
56	.89281	.89678	.90066	.90446	.90818	.91182	.91537	.91885
s	8h 17m	8h 21m	8h 25m	8h 29m	8h 33m	8h 37m	8h 41m	8h 45m
0	9.89287	9.89684	9.90072	9.90452	9.90824	9.91188	9.91543	9.91891
4	.89294	.89691	.90079	.90459	.90830	.91194	.91549	.91896
8	.89301	.89697	.90085	.90465	.90836	.91200	.91555	.91902
12	.89308	.89704	.90092	.90471	.90843	.91206	.91561	.91908
16	.89314	.89710	.90098	.90478	.90849	.91212	.91567	.91914
20	9.89321	9.89717	9.90104	9.90484	9.90855	9.91218	9.91573	9.91919
24	.89328	.89723	.90111	.90490	.90861	.91224	.91578	.91925
28	.89334	.89730	.90117	.90496	.90867	.91230	.91584	.91931
32	.89341	.89736	.90124	.90503	.90873	.91236	.91590	.91936
36	.89348	.89743	.90130	.90509	.90879	.91242	.91596	.91942
40	9.89354	9.89749	9.90136	9.90515	9.90885	9.91248	9.91602	9.91948
44	.89361	.89756	.90143	.90521	.90892	.91254	.91608	.91954
48	.89368	.89763	.90149	.90527	.90898	.91260	.91613	.91959
52	.89374	.89769	.90156	.90534	.90904	.91265	.91619	.91965
56	.89381	.89776	.90162	.90540	.90910	.91271	.91625	.91971
s	8h 18m	8h 22m	8h 26m	8h 30m	8h 34m	8h 38m	8h 42m	8h 46m
0	9.89387	9.89782	9.90168	9.90546	9.90916	9.91277	9.91631	9.91976
4	.89394	.89789	.90175	.90552	.90922	.91283	.91637	.91982
8	.89400	.89795	.90181	.90559	.90928	.91289	.91643	.91988
12	.89407	.89802	.90187	.90565	.90934	.91295	.91648	.91993
16	.89414	.89808	.90194	.90571	.90940	.91301	.91654	.91999
20	9.89421	9.89815	9.90200	9.90577	9.90946	9.91307	9.91660	9.92005
24	.89427	.89821	.90206	.90584	.90952	.91313	.91666	.92010
28	.89434	.89828	.90213	.90590	.90958	.91319	.91672	.92016
32	.89441	.89834	.90219	.90596	.90965	.91325	.91677	.92022
36	.89447	.89840	.90225	.90602	.90971	.91331	.91683	.92027
40	9.89454	9.89847	9.90232	9.90608	9.90977	9.91337	9.91689	9.92033
44	.89460	.89853	.90238	.90615	.90983	.91343	.91695	.92039
48	.89467	.89860	.90244	.90621	.90989	.91349	.91701	.92044
52	.89474	.89866	.90251	.90627	.90995	.91355	.91706	.92050
56	.89480	.89873	.90257	.90633	.91001	.91361	.91712	.92056
s	8h 19m	8h 23m	8h 27m	8h 31m	8h 35m	8h 39m	8h 43m	8h 47m
0	9.89487	9.89879	9.90264	9.90639	9.91007	9.91367	9.91718	9.92061
4	.89493	.89886	.90270	.90646	.91013	.91372	.91724	.92067
8	.89500	.89892	.90276	.90652	.91019	.91378	.91730	.92073
12	.89507	.89899	.90282	.90658	.91025	.91384	.91735	.92078
16	.89513	.89905	.90289	.90664	.91031	.91390	.91741	.92084
20	9.89520	9.89912	9.90295	9.90670	9.91037	9.91396	9.91747	9.92090
24	.89527	.89918	.90301	.90676	.91043	.91402	.91753	.92095
28	.89533	.89925	.90308	.90683	.91049	.91408	.91758	.92101
32	.89540	.89931	.90314	.90689	.91055	.91414	.91764	.92107
36	.89546	.89938	.90320	.90695	.91061	.91420	.91770	.92112
40	9.89553	9.89944	9.90327	9.90701	9.01067	9.91426	9.91776	9.92118
44	.89559	.89950	.90333	.90707	.91074	.91432	.91782	.92124
48	.89566	.89957	.90339	.90714	.91080	.91437	.91787	.92129
52	.89573	.89963	.90346	.90720	.91086	.91443	.91793	.92135
56	.89579	.89970	.90352	.90726	.91092	.91449	.91799	.92140
60	9.89586	9.89976	9.90358	9.90732	9.19098	9.91455	9.91805	9.92146

Table 10. Haversine Table

s	$8^h\ 48^m$	$8^h\ 52^m$	$8^h\ 56^m$	$9^h\ 0^m$	$9^h\ 4^m$	$9^h\ 8^m$	$9^h\ 12^m$	$9^h\ 16^m$
	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.	Hav.
0	9.92146	9.92480	9.92805	9.93123	9.93433	9.93736	9.94030	9.94318
4	.92152	.92485	.92811	.93128	.93438	.93741	.94035	.94322
8	.92157	.92491	.92816	.93134	.93443	.93746	.94040	.94327
12	.92163	.92496	.92821	.93139	.93448	.93751	.94045	.94332
16	.92169	.92502	.92827	.93144	.93454	.93755	.94050	.94336
20	9.92174	9.92507	9.92832	9.93149	9.93459	9.93760	9.94055	9.94341
24	.92180	.92512	.92837	.93154	.93464	.93765	.94059	.94346
28	.92185	.92518	.92843	.93160	.93469	.93770	.94064	.94351
32	.92191	.92523	.92848	.93165	.93474	.93775	.94069	.94355
36	.92197	.92529	.92853	.93170	.93479	.93780	.94074	.94360
40	9.92202	9.92534	9.92859	9.93175	9.93484	9.93785	9.94079	9.94365
44	.92208	.92540	.92864	.93181	.93489	.93790	.94084	.94369
48	.92213	.92545	.92869	.93186	.93494	.93795	.94088	.94374
52	.92219	.92551	.92875	.93191	.93499	.93800	.94093	.94379
56	.92225	.92556	.92880	.93196	.93504	.93805	.94098	.94383

s	$8^h\ 49^m$	$8^h\ 53^m$	$8^h\ 57^m$	$9^h\ 1^m$	$9^h\ 5^m$	$9^h\ 9^m$	$9^h\ 13^m$	$9^h\ 17^m$
0	9.92230	9.92562	9.92885	9.93201	9.93509	9.93810	9.94103	9.94388
4	.92236	.92567	.92891	.93207	.93515	.93815	.94108	.94393
8	.92241	.92573	.92896	.93212	.93520	.93820	.94112	.94398
12	.92247	.92578	.92901	.93217	.93525	.93825	.94117	.94402
16	.92253	.92584	.92907	.93222	.93530	.93830	.94122	.94407
20	9.92258	9.92589	9.92912	9.93227	9.93535	9.93835	9.94127	9.94412
24	.92264	.92594	.92917	.93232	.93540	.93840	.94132	.94416
28	.92269	.92600	.92923	.93238	.93545	.93845	.94137	.94421
32	.92275	.92605	.92928	.93243	.93550	.93849	.94141	.94426
36	.92280	.92611	.92933	.93248	.93555	.93854	.94146	.94430
40	9.92286	9.92616	9.92939	9.93253	9.93560	9.93859	9.94151	9.94435
44	.92292	.92622	.92944	.93258	.93565	.93864	.94156	.94440
48	.92297	.92627	.92949	.93264	.93570	.93869	.94161	.94444
52	.92303	.92633	.92955	.93269	.93575	.93874	.94165	.94449
56	.92308	.92638	.92960	.93274	.93580	.93879	.94170	.94454

s	$8^h\ 50^m$	$8^h\ 54^m$	$8^h\ 58^m$	$9^h\ 2^m$	$9^h\ 6^m$	$9^h\ 10^m$	$9^h\ 14^m$	$9^h\ 18^m$
0	9.92314	9.92643	9.92965	9.93279	9.93585	9.93884	9.94175	9.94458
4	.92319	.92649	.92970	.93284	.93590	.93889	.94180	.94463
8	.92325	.92654	.92975	.93289	.93595	.93894	.94184	.94468
12	.92330	.92660	.92981	.93295	.93600	.93899	.94189	.94472
16	.92336	.92665	.92986	.93300	.93605	.93904	.94194	.94477
20	9.92342	9.92670	9.92992	9.93305	9.93611	9.93908	9.94199	9.94482
24	.92347	.92676	.92997	.93310	.93616	.93913	.94204	.94486
28	.92353	.92681	.93002	.93315	.93621	.93918	.94208	.94491
32	.92358	.92687	.93007	.93320	.93626	.93923	.94213	.94496
36	.92364	.92692	.93013	.93326	.93631	.93928	.94218	.94500
40	9.92369	9.92698	9.93018	9.93331	9.93636	9.93933	9.94223	9.94505
44	.92375	.92703	.93023	.93336	.93641	.93938	.94227	.94509
48	.92380	.92708	.93029	.93341	.93646	.93943	.94232	.94514
52	.92386	.92714	.93034	.93346	.93651	.93948	.94237	.94519
56	.92391	.92719	.93039	.93351	.93656	.93952	.94242	.94523

s	$8^h\ 51^m$	$8^h\ 55^m$	$8^h\ 59^m$	$9^h\ 3^m$	$9^h\ 7^m$	$9^h\ 11^m$	$9^h\ 15^m$	$9^h\ 19^m$
0	9.92397	9.92725	9.93044	9.93356	9.93661	9.93957	9.94246	9.94528
4	.92402	.92730	.93050	.93362	.93666	.93962	.94251	.94533
8	.92408	.92735	.93055	.93367	.93671	.93967	.94256	.94537
12	.92413	.92741	.93060	.93372	.93676	.93972	.94261	.94542
16	.92419	.92746	.93065	.93377	.93681	.93977	.94265	.94546
20	9.92425	9.92751	9.93071	9.93382	9.93686	9.93982	9.94270	9.94551
24	.92430	.92757	.93076	.93387	.93691	.93987	.94275	.94556
28	.92436	.92762	.93081	.93392	.93696	.93991	.94280	.94560
32	.92441	.92768	.93086	.93397	.93701	.93996	.94284	.94565
36	.92447	.92773	.93092	.93403	.93706	.94001	.94289	.94570
40	9.92452	9.92778	9.93097	9.93408	9.93711	9.94006	9.94294	9.94574
44	.92458	.92784	.93102	.93413	.93716	.94011	.94299	.94579
48	.92463	.92789	.93107	.93418	.93721	.94016	.94303	.94583
52	.92469	.92794	.93113	.93423	.93726	.94021	.94308	.94588
56	.92474	.92800	.93118	.93428	.93731	.94026	.94313	.94593
60	9.92480	9.92805	9.93123	9.93433	9.93736	9.94030	9.94318	9.94597

s	$9^h 20^m$ Hav.	$9^h 24^m$ Hav.	$9^h 28^m$ Hav.	$9^h 32^m$ Hav.	$9^h 36^m$ Hav.	$9^h 40^m$ Hav.	$9^h 44^m$ Hav.	$9^h 48^m$ Hav.
0	9.94597	9.94869	9.95134	9.95391	9.95641	9.95884	9.96119	9.96347
4	.94602	.94874	.95138	.95396	.95645	.95888	.96123	.96351
8	.94606	.94878	.95143	.95400	.95649	.95892	.96127	.96355
12	.94611	.94883	.95147	.95404	.95654	.95896	.96131	.96359
16	.94616	.94887	.95151	.95408	.95658	.95900	.96135	.96362
20	9.94620	9.94892	9.95156	9.95412	9.95662	9.95904	9.96139	9.96366
24	.94625	.94896	.95160	.95417	.95666	.95908	.96142	.96370
28	.94629	.94901	.95164	.95421	.95670	.95912	.96146	.96374
32	.94634	.94905	.95169	.95425	.95674	.95916	.96150	.96377
36	.94638	.94909	.95173	.95429	.95678	.95920	.96154	.96381
40	9.94643	9.94914	9.95177	9.95433	9.95682	9.95924	9.96158	9.96385
44	.94648	.94918	.95182	.95438	.95686	.95928	.96162	.96388
48	.94652	.94923	.95186	.95442	.95690	.95932	.96165	.96392
52	.94657	.94927	.95190	.95446	.95694	.95936	.96169	.96396
56	.94661	.94932	.95195	.95450	.95699	.95939	.96173	.96400
s	$9^h 21^m$	$9^h 25^m$	$9^h 29^m$	$9^h 33^m$	$9^h 37^m$	$9^h 41^m$	$9^h 45^m$	$9^h 49^m$
0	9.94666	9.94936	9.95199	9.95454	9.95703	9.95943	9.96177	9.96403
4	.94670	.94941	.95203	.95459	.95707	.95947	.96181	.96407
8	.94675	.94945	.95208	.95463	.95711	.95951	.96185	.96411
12	.94680	.94950	.95212	.95467	.95715	.95955	.96188	.96412
16	.94684	.94954	.95216	.95471	.95719	.95959	.96192	.96418
20	9.94689	9.94958	9.95221	9.95475	9.95723	9.95963	9.96196	9.96422
24	.94693	.94963	.95225	.95480	.95727	.95967	.96200	.96426
28	.94698	.94967	.95229	.95484	.95731	.95971	.96204	.96429
32	.94702	.94972	.95234	.95488	.95735	.95975	.96208	.96433
36	.94707	.94976	.95238	.95492	.95739	.95979	.96211	.96437
40	9.94711	9.94981	9.95242	9.95496	9.95743	9.95983	9.96215	9.96440
44	.94716	.94985	.95246	.95501	.95747	.95987	.96219	.96444
48	.94721	.94989	.95251	.95505	.95751	.95991	.96223	.96448
52	.94725	.94994	.95255	.95509	.95755	.95995	.96227	.96451
56	.94730	.94998	.95259	.95513	.95759	.95999	.96230	.96455
s	$9^h 22^m$	$9^h 26^m$	$9^h 30^m$	$9^h 34^m$	$9^h 38^m$	$9^h 42^m$	$9^h 46^m$	$9^h 50^m$
0	9.94734	9.95003	9.95264	9.95517	9.95763	9.96002	9.96234	9.96459
4	.94739	.95007	.95268	.95521	.95768	.96006	.96238	.96462
8	.94743	.95011	.95272	.95526	.95772	.96010	.96242	.96466
12	.94748	.95016	.95276	.95530	.95776	.96014	.96246	.96470
16	.94752	.95020	.95281	.95534	.95780	.96018	.96249	.96473
20	9.94757	9.95025	9.95285	9.95538	9.95784	9.96022	9.96253	9.96477
24	.94761	.95029	.95289	.95542	.95788	.96026	.96257	.96481
28	.94766	.95033	.95294	.95546	.95792	.96030	.96261	.96484
32	.94770	.95038	.95298	.95550	.95796	.96034	.96265	.96488
36	.94774	.95042	.95302	.95555	.95800	.96038	.96268	.96492
40	9.94779	9.95047	9.95306	9.95559	9.95804	9.96042	9.96272	9.96495
44	.94784	.95051	.95311	.95563	.95808	.96046	.96276	.96499
48	.94788	.95055	.95315	.95567	.95812	.96049	.96280	.96503
52	.94793	.95060	.95319	.95571	.95816	.96053	.96283	.96506
56	.94797	.95064	.95323	.95575	.95820	.96057	.96287	.96510
s	$9^h 23^m$	$9^h 27^m$	$9^h 31^m$	$9^h 35^m$	$9^h 39^m$	$9^h 43^m$	$9^h 47^m$	$9^h 51^m$
0	9.94802	9.95069	9.95328	9.95579	9.95824	9.96061	9.96291	9.96514
4	.94806	.95073	.95332	.95584	.95828	.96065	.96295	.96517
8	.94811	.95077	.95336	.95588	.95832	.96069	.96299	.96521
12	.94815	.95082	.95340	.95592	.95836	.96073	.96302	.96525
16	.94820	.95086	.95345	.95596	.95840	.96077	.96306	.96528
20	9.94824	9.95090	9.95349	9.95600	9.95844	9.96081	9.96310	9.96532
24	.94829	.95095	.95353	.95604	.95848	.96084	.96314	.96536
28	.94833	.95099	.95357	.95608	.95852	.96088	.96317	.96539
32	.94838	.95104	.95362	.95613	.95856	.96092	.96321	.96543
36	.94842	.95108	.95366	.95617	.95860	.96096	.96325	.96547
40	9.94847	9.95112	9.95370	9.95621	9.95864	9.96100	9.96329	9.96550
44	.94851	.95117	.95374	.95625	.95868	.96104	.96332	.96554
48	.94856	.95121	.95379	.95629	.95872	.96108	.96336	.96557
52	.94860	.95125	.95383	.95633	.95876	.96112	.96340	.96561
56	.94865	.95130	.95387	.95637	.95880	.96115	.96344	.96565
60	9.94869	9.95134	9.95391	9.95641	9.95884	9.96119	9.96347	9.96568

s	$9^h\,52^m$	$9^h\,56^m$	$10^h\,0^m$	$10^h\,4^m$	$10^h\,8^m$	$10^h\,12^m$	$10^h\,16^m$	$10^h\,20^m$
	Hav.	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**	**Hav.**
0	9.96568	9.96782	9.96989	9.97188	9.97381	9.97566	9.97745	9.97916
4	.96572	.96786	.96992	.97192	.97384	.97569	.97748	.97919
8	.96576	.96789	.96996	.97195	.97387	.97572	.97751	.97922
12	.96579	.96793	.96999	.97198	.97390	.97575	.97754	.97925
16	.96583	.96796	.97002	.97201	.97393	.97578	.97756	.97927
20	9.96586	9.96800	9.97006	9.97205	9.97397	9.97581	9.97759	9.97930
24	.96590	.96803	.97009	.97208	.97400	.97584	.97762	.97933
28	.96594	.96807	.97012	.97211	.97403	.97587	.97765	.97936
32	.96597	.96810	.97016	.97214	.97406	.97591	.97768	.97939
36	.96601	.96814	.97019	.97218	.97409	.97594	.97771	.97941
40	9.96604	9.96817	9.97022	9.97221	9.97412	9.97597	9.97774	9.97944
44	.96608	.96821	.97026	.97224	.97415	.97600	.97777	.97947
48	.96612	.96824	.97029	.97227	.97418	.97603	.97780	.97950
52	.96615	.96827	.97033	.97231	.97422	.97606	.97783	.97953
56	.96619	.96831	.97036	.97234	.97425	.97609	.97785	.97955

s	$9^h\,53^m$	$9^h\,57^m$	$10^h\,1^m$	$10^h\,5^m$	$10^h\,9^m$	$10^h\,13^m$	$10^h\,17^m$	$10^h\,21^m$
0	9.96622	9.96834	9.97039	9.97237	9.97428	9.97612	9.97788	9.97958
4	.96626	.96837	.97043	.97240	.97431	.97615	.97791	.97961
8	.96630	.96841	.97046	.97244	.97434	.97618	.97794	.97964
12	.96633	.96845	.97049	.97247	.97437	.97621	.97797	.97966
16	.96637	.96848	.97052	.97250	.97440	.97624	.97800	.97969
20	9.96640	9.96852	9.97056	9.97253	9.97443	9.97627	9.97803	9.97972
24	.96644	.96855	.97059	.97257	.97447	.97630	.97806	.97975
28	.96648	.96859	.97063	.97260	.97450	.97633	.97808	.97977
32	.96651	.96862	.97066	.97263	.97453	.97636	.97811	.97980
36	.96655	.96866	.97069	.97266	.97456	.97639	.97814	.97983
40	9.96658	9.96869	9.97073	9.97269	9.97459	9.97642	9.97817	9.97986
44	.96662	.96873	.97076	.97273	.97462	.97645	.97820	.97988
48	.96665	.96876	.97079	.97276	.97465	.97647	.97823	.97991
52	.96669	.96879	.97083	.97279	.97468	.97650	.97826	.97994
56	.96673	.96883	.97086	.97282	.97471	.97653	.97829	.97997

s	$9^h\,54^m$	$9^h\,58^m$	$10^h\,2^m$	$10^h\,6^m$	$10^h\,10^m$	$10^h\,14^m$	$10^h\,18^m$	$10^h\,22^m$
0	9.96676	9.96886	9.97089	9.97285	9.97474	9.97656	9.97831	9.97999
4	.96680	.96890	.97093	.97289	.94478	.97659	.97834	.98002
8	.96683	.96894	.97096	.96292	.97481	.97662	.97837	.98005
12	.96687	.96897	.97099	.97295	.97484	.97665	.97840	.98008
16	.96690	.96900	.97103	.97298	.97487	.97668	.97843	.98010
20	9.96694	9.96904	9.97106	9.97301	9.97490	9.97671	9.97846	9.98013
24	.96697	.96907	.97109	.97305	.97493	.97674	.97849	.98016
28	.96701	.96910	.97113	.97308	.97496	.97677	.97851	.98019
32	.96705	.96914	.97116	.97311	.97499	.97680	.97854	.98021
36	.96708	.96917	.97119	.97314	.97502	.97683	.97857	.98024
40	9.96712	9.96921	9.97123	9.97317	9.97505	9.97686	9.97860	9.98027
44	.96715	.96924	.97126	.97321	.97508	.97689	.97863	.98030
48	.96719	.96928	.97129	.97324	.97511	.97692	.97866	.98032
52	.96722	.96931	.97132	.97327	.97514	.97695	.97868	.98035
56	.96726	.96934	.97136	.97330	.97518	.97698	.97871	.98038

s	$9^h\,55^m$	$9^h\,59^m$	$10^h\,3^m$	$10^h\,7^m$	$10^h\,11^m$	$10^h\,15^m$	$10^h\,19^m$	$10^h\,23^m$
0	9.96729	9.96938	9.97139	9.97333	9.97521	9.97701	9.97874	9.98040
4	.96733	.96941	.97142	.97337	.97524	.97704	.97877	.98043
8	.96736	.96945	.97146	.97340	.97527	.97707	.97880	.98046
12	.96740	.96948	.97149	.97343	.97530	.97710	.97883	.98049
16	.96743	.96951	.97152	.97346	.97533	.97713	.97885	.98051
20	9.96747	9.96955	9.97156	9.97349	9.97536	9.97716	9.97888	9.98054
24	.96750	.96958	.97159	.97352	.97539	.97718	.97891	.98057
28	.96754	.96962	.97162	.97356	.97542	.97721	.97894	.98059
32	.96758	.96965	.97165	.97359	.97545	.97724	.97897	.98062
36	.98761	.96968	.97169	.97362	.97548	.97727	.97899	.98065
40	9.96765	9.96972	9.97172	9.97365	9.97551	9.97730	9.97902	9.98067
44	.96768	.96975	.97175	.97368	.97554	.97733	.97905	.98070
48	.96772	.96979	.97179	.97371	.97557	.97736	.97908	.98073
52	.96775	.96982	.97182	.97375	.97560	.97739	.97911	.98076
56	.96779	.96985	.97185	.97378	.97563	.97742	.97914	.98078
60	9.96782	9.96989	9.97188	9.97381	9.97566	9.97745	9.97916	9.98081

s	$10^h 24^m$ Hav.	$10^h 28^m$ Hav.	$10^h 32^m$ Hav.	$10^h 36^m$ Hav.	$10^h 40^m$ Hav.	$10^h 44^m$ Hav.	$10^h 48^m$ Hav.	$10^h 52^m$ Hav.
0	9.98081	9.98239	9.98389	9.98533	9.98670	9.98801	9.98924	9.99041
4	.98084	.98241	.98392	.98536	.98673	.98803	.98926	.99043
8	.98086	.98244	.98394	.98538	.98675	.98805	.98928	.99044
12	.98089	.98246	.98397	.98540	.98677	.98807	.98930	.99046
16	.98092	.98249	.98399	.98543	.98679	.98809	.98932	.99048
20	9.98094	9.98251	9.98402	9.98545	9.98681	9.98811	9.98934	9.99050
24	.98097	.98254	.98404	.98547	.98684	.98813	.98936	.99052
28	.98100	.98256	.98406	.98550	.98686	.98815	.98938	.99054
32	.98102	.98259	.98409	.98552	.98688	.98817	.98940	.99056
36	.98105	.98262	.98411	.98554	.98690	.98819	.98942	.99058
40	9.98108	9.98264	9.98414	9.98557	9.98692	9.98822	9.98944	9.99059
44	.98110	.98267	.98416	.98559	.98695	.98824	.98946	.99061
48	.98113	.98269	.98419	.98561	.98697	.98826	.98948	.99063
52	.98116	.98272	.98421	.98564	.98699	.98828	.98950	.99065
56	.98118	.98274	.98424	.98566	.98701	.98830	.98952	.99067

s	$10^h 25^m$	$10^h 29^m$	$10^h 33^m$	$10^h 37^m$	$10^h 41^m$	$10^h 45^m$	$10^h 49^m$	$10^h 53^m$
0	9.98121	9.98277	9.98426	9.98568	9.98703	9.98832	9.98954	9.99069
4	.98124	.98279	.98428	.98570	.98706	.98834	.98956	.99071
8	.98126	.98282	.98431	.98573	.98708	.98836	.98958	.99072
12	.98129	.98285	.98433	.98575	.98710	.98838	.98960	.99074
16	.98132	.98287	.98436	.98577	.98712	.98840	.98962	.99076
20	9.98134	9.98290	9.98438	9.98580	9.98714	9.98842	9.98964	9.99078
24	.98137	.98292	.98440	.98582	.98717	.98845	.98966	.99080
28	.98139	.98295	.98443	.98584	.98719	.98847	.98968	.99082
32	.98142	.98297	.98445	.98587	.98721	.98849	.98970	.99084
36	.98145	.98300	.98448	.98589	.98723	.98851	.98971	.99085
40	9.98147	9.98302	9.98450	9.98591	9.98725	9.98853	9.98973	9.99087
44	.98150	.98305	.98453	.98593	.98728	.98855	.98975	.99089
48	.98153	.98307	.98455	.98596	.98730	.98857	.98977	.99091
52	.98155	.98310	.98457	.98598	.98732	.98859	.98979	.99093
56	.98158	.98312	.98460	.98600	.98734	.98861	.98981	.99095

s	$10^h 26^m$	$10^h 30^m$	$10^h 34^m$	$10^h 38^m$	$10^h 42^m$	$10^h 46^m$	$10^h 50^m$	$10^h 54^m$
0	9.98161	9.98315	9.98462	9.98603	9.98736	9.98863	9.98983	9.99096
4	.98163	.98317	.98465	.98605	.98738	.98865	.98985	.99098
8	.98166	.98320	.98467	.98607	.98741	.98867	.98987	.99100
12	.98168	.98322	.98469	.98609	.98743	.98869	.98989	.99102
16	.98171	.98325	.98472	.98612	.98745	.98871	.98991	.99104
20	9.98174	9.98327	9.98474	9.98614	9.98747	9.98873	9.98993	9.99106
24	.98176	.98330	.98476	.98616	.98749	.98875	.98995	.99107
28	.98179	.98332	.98479	.98619	.98751	.98877	.98997	.99109
32	.98182	.98335	.98481	.98621	.98754	.98880	.98999	.99111
36	.98184	.98337	.98484	.98623	.98756	.98882	.99001	.99113
40	9.98187	9.98340	9.98486	9.98625	9.98758	9.98884	9.99003	9.99115
44	.98189	.98342	.98488	.98628	.98760	.98886	.99004	.99116
48	.98192	.98345	.98491	.98630	.98762	.98888	.99006	.99118
52	.98195	.98347	.98493	.98632	.98764	.98890	.99008	.99120
56	.98197	.98350	.98496	.98634	.98766	.98892	.99010	.99122

s	$10^h 27^m$	$10^h 31^m$	$10^h 35^m$	$10^h 39^m$	$10^h 43^m$	$10^h 47^m$	$10^h 51^m$	$10^h 55^m$
0	9.98200	9.98352	9.98498	9.98637	9.98769	9.98894	9.99012	9.99124
4	.98202	.98355	.98500	.98639	.98771	.98896	.99014	.99126
8	.98205	.98357	.98503	.98641	.98773	.98898	.99016	.99127
12	.98208	.98360	.98505	.98643	.98775	.98900	.99018	.99129
16	.98210	.98362	.98507	.98646	.98777	.98902	.99020	.99131
20	9.98213	9.98365	9.98510	9.98648	9.98779	9.98904	9.99022	9.99133
24	.98215	.98367	.98512	.98650	.98781	.98906	.99024	.99135
28	.98218	.98370	.98514	.98652	.98784	.98908	.99026	.99136
32	.98221	.98372	.98517	.98655	.98786	.98910	.99027	.99138
36	.98223	.98375	.98519	.98657	.98788	.98912	.99029	.99140
40	9.98226	9.98377	9.98521	9.98659	9.98790	9.98914	9.99031	9.99142
44	.98228	.98379	.98524	.98661	.98792	.98916	.99033	.99143
48	.98231	.98382	.98526	.98664	.98794	.98918	.99035	.99145
52	.98233	.98384	.98529	.98666	.98796	.98920	.99037	.99147
56	.98236	.98387	.98531	.98668	.98798	.98922	.99039	.99149
60	9.98239	9.98389	9.98533	9.98670	9.98801	9.98924	9.99041	9.99151

s	$10^h 56^m$ Hav.	$11^h 0^m$ Hav.	$11^h 4^m$ Hav.	$11^h 8^m$ Hav.	$11^h 12^m$ Hav.	$11^h 16^m$ Hav.	$11^h 20^m$ Hav.	$11^h 24^m$ Hav.
0	9.99151	9.99254	9.99350	9.99440	9.99523	9.99599	9.99669	9.99732
4	.99152	.99255	.99352	.99441	.99524	.99600	.99670	.99733
8	.99154	.99257	.99353	.99443	.99526	.99602	.99671	.99734
12	.99156	.99259	.99355	.99444	.99527	.99603	.99672	.99735
16	.99158	.99260	.99356	.99446	.99528	.99604	.99673	.99736
20	9.99159	9.99262	9.99358	9.99447	9.99529	9.99605	9.99674	9.99737
24	.99161	.99264	.99359	.99448	.99531	.99606	.99675	.99738
28	.99163	.99265	.99361	.99450	.99532	.99608	.99677	.99739
32	.99165	.99267	.99362	.99451	.99533	.99609	.99678	.99740
36	.99166	.99269	.99364	.99453	.99535	.99610	.99679	.99741
40	9.99168	9.99270	9.99366	9.99454	9.99536	9.99611	9.99680	9.99742
44	.99170	.99272	.99367	.99456	.99537	.99612	.99681	.99743
48	.99172	.99274	.99369	.99457	.99539	.99614	.99682	.99744
52	.99173	.99275	.99370	.99458	.99540	.99615	.99683	.99745
56	.99175	.99277	.99372	.99460	.99541	.99616	.99684	.99746

s	$10^h 57^m$	$11^h 1^m$	$11^h 5^m$	$11^h 9^m$	$11^h 13^m$	$11^h 17^m$	$11^h 21^m$	$11^h 25^m$
0	9.99177	9.99278	9.99373	9.99461	9.99543	9.99617	9.99685	9.99747
4	.99179	.99280	.99375	.99463	.99544	.99618	.99686	.99748
8	.99180	.99282	.99376	.99464	.99545	.99620	.99687	.99748
12	.99182	.99283	.99378	.99465	.99546	.99621	.99688	.99749
16	.99184	.99285	.99379	.99467	.99548	.99622	.99690	.99750
20	9.99186	9.99287	9.99381	9.99468	9.99549	9.99623	9.99691	9.99751
24	.99187	.99288	.99382	.99470	.99550	.99624	.99692	.99752
28	.99189	.99290	.99384	.99471	.99552	.99626	.99693	.99753
32	.99191	.99291	.99385	.99472	.99553	.99627	.99694	.99754
36	.99193	.99293	.99387	.99474	.99554	.99628	.99695	.99755
40	9.99194	9.99295	9.99388	9.99475	9.99555	9.99629	9.99696	9.99756
44	.99196	.99296	.99390	.99477	.99557	.99630	.99697	.99757
48	.99198	.99298	.99391	.99478	.99558	.99631	.99698	.99758
52	.99200	.99300	.99393	.99479	.99559	.99633	.99699	.99759
56	.99201	.99301	.99394	.99481	.99561	.99634	.99700	.99760

s	$10^h 58^m$	$11^h 2^m$	$11^h 6^m$	$11^h 10^m$	$11^h 14^m$	$11^h 18^m$	$11^h 22^m$	$11^h 26^m$
0	9.99203	9.99303	9.99396	9.99482	9.99562	9.99635	9.99701	9.99761
4	.99205	.99304	.99397	.99484	.99563	.99636	.99702	.99762
8	.99206	.99306	.99399	.99485	.99564	.99637	.99703	.99763
12	.99208	.99308	.99400	.99486	.99566	.99638	.99704	.99764
16	.99210	.99309	.99402	.99488	.99567	.99639	.99705	.99765
20	9.99212	9.99311	9.99403	9.99489	9.99568	9.99641	9.99706	9.99766
24	.99213	.99312	.99405	.99490	.99569	.99642	.99707	.99766
28	.99215	.99314	.99406	.99492	.99571	.99643	.99708	.99767
32	.99217	.99316	.99408	.99493	.99572	.99644	.99710	.99768
36	.99218	.99317	.99409	.99495	.99573	.99645	.99711	.99769
40	9.99220	9.99319	9.99411	9.99496	9.99575	9.99646	9.99712	9.99770
44	.99222	.99320	.99412	.99497	.99576	.99648	.99713	.99771
48	.99223	.99322	.99414	.99499	.99577	.99649	.99714	.99772
52	.99225	.99324	.99415	.99500	.99578	.99650	.99715	.99773
56	.99227	.99325	.99417	.99501	.99580	.99651	.99716	.99774

s	$10^h 59^m$	$11^h 3^m$	$11^h 7^m$	$11^h 11^m$	$11^h 15^m$	$11^h 19^m$	$11^h 23^m$	$11^h 27^m$
0	9.99229	9.99327	9.99418	9.99503	9.99581	9.99652	9.99717	9.99774
4	.99230	.99328	.99420	.99504	.99582	.99653	.99718	.99775
8	.99232	.99330	.99421	.99505	.99583	.99654	.99719	.99776
12	.99234	.99331	.99422	.99507	.99584	.99655	.99720	.99777
16	.99235	.99333	.99424	.99508	.99586	.99657	.99721	.99778
20	9.99237	9.99335	9.99425	9.99510	9.99587	9.99658	9.99722	9.99779
24	.99239	.99336	.99427	.99511	.99588	.99659	.99723	.99780
28	.99240	.99338	.99429	.99512	.99589	.99660	.99724	.99781
32	.99242	.99339	.99430	.99514	.99591	.99661	.99725	.99782
36	.99244	.99341	.99431	.99515	.99592	.99662	.99726	.99783
40	9.99245	9.99342	9.99433	9.99516	9.99593	9.99663	9.99727	9.99784
44	.99247	.99344	.99434	.99518	.99594	.99664	.99728	.99785
48	.99249	.99345	.99436	.99519	.99596	.99666	.99729	.99786
52	.99250	.99347	.99437	.99520	.99597	.99667	.99730	.99786
56	.99252	.99349	.99438	.99522	.99598	.99668	.99731	.99787
60	9.99254	9.99350	9.99440	9.99523	9.99599	9.99669	9.99732	9.99788

s	11h 28m Hav.	11h 32m Hav.	11h 36m Hav.	11h 40m Hav.	11h 44m Hav.	11h 48m Hav.	11h 52m Hav.	11h 56m Hav.
0	9.99788	9.99838	9.99881	9.99917	9.99947	9.99970	9.99987	9.99997
4	.99789	.99839	.99882	.99918	.99948	.99971	.99987	.99997
8	.99790	.99839	.99882	.99918	.99948	.99971	.99987	.99997
12	.99791	.99840	.99883	.99919	.99948	.99971	.99987	.99997
16	.99792	.99841	.99884	.99919	.99949	.99972	.99988	.99997
20	9.99793	9.99842	9.99884	9.99920	9.99949	9.99972	9.99988	9.99997
24	.99793	.99842	.99885	.99921	.99950	.99972	.99988	.99997
28	.99794	.99843	.99885	.99921	.99950	.99973	.99988	.99997
32	.99795	.99844	.99886	.99922	.99951	.99973	.99988	.99998
36	.99796	.99845	.99887	.99922	.99951	.99973	.99989	.99998
40	9.99797	9.99845	9.99887	9.99923	9.99951	9.99973	9.99989	9.99998
44	.99798	.99846	.99888	.99923	.99952	.99974	.99989	.99998
48	.99799	.99847	.99889	.99924	.99952	.99974	.99989	.99998
52	.99800	.99848	.99889	.99924	.99953	.99974	.99989	.99998
56	.99800	.99848	.99890	.99925	.99953	.99975	.99990	.99998
s	11h 29m	11h 33m	11h 37m	11h 41m	11h 45m	11h 49m	11h 53m	11h 57m
0	9.99801	9.99849	9.99891	9.99925	9.99953	9.99975	9.99990	9.99998
4	.99802	.99850	.99891	.99926	.99954	.99975	.99990	.99998
8	.99803	.99851	.99892	.99926	.99954	.99976	.99990	.99998
12	.99804	.99851	.99893	.99927	.99954	.99976	.99990	.99998
16	.99805	.99852	.99893	.99927	.99955	.99976	.99991	.99998
20	9.99805	9.99853	9.99894	9.99928	9.99955	9.99976	9.99991	9.99999
24	.99806	.99854	.99894	.99928	.99956	.99977	.99991	.99999
28	.99807	.99854	.99895	.99929	.99956	.99977	.99991	.99999
32	.99808	.99855	.99896	.99929	.99957	.99977	.99991	.99999
36	.99809	.99856	.99896	.99930	.99957	.99978	.99992	.99999
40	9.99810	9.99857	9.99897	9.99931	9.99958	9.99978	9.99992	9.99999
44	.99811	.99857	.99897	.99931	.99958	.99978	.99992	.99999
48	.99811	.99858	.99898	.99932	.99958	.99978	.99992	.99999
52	.99812	.99859	.99899	.99932	.99959	.99979	.99992	.99999
56	.99813	.99859	.99899	.99933	.99959	.99979	.99992	.99999
s	11h 30m	11h 34m	11h 38m	11h 42m	11h 46m	11h 50m	11h 54m	11h 58m
0	9.99814	9.99860	9.99900	9.99933	9.99959	9.99979	9.99993	9.99999
4	.99815	.99861	.99901	.99934	.99960	.99980	.99993	.99999
8	.99815	.99862	.99901	.99934	.99960	.99980	.99993	.99999
12	.99816	.99862	.99902	.99935	.99961	.99980	.99993	.99999
16	.99817	.99863	.99902	.99935	.99961	.99980	.99993	.99999
20	9.99818	9.99864	9.99903	9.99935	9.99961	9.99981	9.99993	9.99999
24	.99819	.99864	.99904	.99936	.99962	.99981	.99994	.99999
28	.99820	.99865	.99904	.99936	.99962	.99981	.99994	.00000
32	.99820	.99866	.99905	.99937	.99963	.99981	.99994	.00000
36	.99821	.99867	.99905	.99937	.99963	.99982	.99994	.00000
40	9.99822	9.99867	9.99906	9.99938	9.99963	9.99982	9.99994	0.00000
44	.99823	.99868	.99906	.99938	.99964	.99982	.99994	.00000
48	.99824	.99869	.99907	.99939	.99964	.99983	.99994	.00000
52	.99824	.99869	.99908	.99939	.99964	.99983	.99995	.00000
56	.99825	.99870	.99908	.99940	.99965	.99983	.99995	.00000
s	11h 31m	11h 35m	11h 39m	11h 43m	11h 47m	11h 51m	11h 55m	11h 59m
0	9.99826	9.99871	9.99909	9.99940	9.99965	9.99983	9.99995	0.00000
4	.99827	.99871	.99909	.99941	.99965	.99983	.99995	.00000
8	.99828	.99872	.99910	.99941	.99966	.99984	.99995	.00000
12	.99828	.99873	.99911	.99942	.99966	.99984	.99995	.00000
16	.99829	.99874	.99911	.99942	.99966	.99984	.99995	.00000
20	9.99830	9.99874	9.99912	9.99943	9.99967	9.99984	9.99996	0.00000
24	.99831	.99875	.99912	.99943	.99967	.99985	.99996	.00000
28	.99832	.99876	.99913	.99943	.99968	.99985	.99996	.00000
32	.99832	.99876	.99913	.99944	.99968	.99985	.99996	.00000
36	.99833	.99877	.99914	.99944	.99968	.99985	.99996	.00000
40	9.99834	9.99878	9.99915	9.99945	9.99969	9.99986	9.99996	0.00000
44	.99835	.99878	.99915	.99945	.99969	.99986	.99996	.00000
48	.99836	.99879	.99916	.99946	.99969	.99986	.99996	.00000
52	.99836	.99880	.99916	.99946	.99970	.99986	.99996	.00000
56	.99837	.99880	.99917	.99947	.99970	.99987	.99997	.00000
60	9.99838	9.99881	9.99917	9.99947	9.99970	9.99987	9.99997	0.00000

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-angle for a Star Observation								
Use these in Fore-noon →	*12h 0m* *24 0*	*12h 8m* *23 52*	*12h 16m* *23 44*	*12h 24m* *23 36*	*12h 32m* *23 28*	*12h 40m* *23 20*	*12h 48m* *23 12*	*12h 56m* *23 4*	← Use these in Fore-noon
Use these in After-noon →	*0h 0m* *12 0*	*0h 8m* *11 52*	*0h 16m* *11 44*	*0h 24m* *11 36*	*0h 32m* *11 28*	*0h 40m* *11 20*	*0h 48m* *11 12*	*0h 56m* *11 4*	← Use these in After-noon
Declinations									Altitudes
0°	0	349	698	1045	1392	1737	2079	2419	**0°**
2	0	349	697	1045	1391	1736	2078	2417	2
4	0	348	696	1042	1389	1732	2074	2413	4
6	0	347	694	1040	1384	1726	2067	2406	6
8	0	346	691	1035	1378	1720	2059	2395	8
10	0	344	687	1029	1371	1710	2047	2382	**10**
12	0	341	682	1022	1361	1698	2033	2367	12
14	0	339	677	1015	1351	1685	2018	2347	14
16	0	336	671	1005	1338	1669	1998	2326	16
18	0	332	663	994	1323	1651	1977	2301	18
20	0	328	656	982	1308	1632	1954	2274	**20**
22	0	324	647	969	1290	1610	1928	2244	22
24	0	319	637	955	1272	1586	1900	2210	24
26	0	314	627	940	1251	1561	1868	2174	26
28	0	308	616	923	1228	1533	1835	2136	28
30	0	302	604	905	1205	1504	1801	2095	**30**
32	0	296	592	886	1180	1472	1763	2051	32
34	0	289	578	867	1153	1440	1724	2005	34
36	0	282	564	846	1126	1405	1682	1957	36
38	0	275	550	824	1096	1369	1639	1906	38
40	0	267	534	801	1066	1330	1592	1853	**40**
42	0	259	518	777	1034	1290	1545	1798	42
44	0	251	502	752	1001	1249	1496	1740	44
46	0	242	485	726	967	1206	1444	1681	46
48	0	234	467	699	931	1162	1391	1619	48
50	0	224	448	672	895	1116	1337	1555	**50**
52	0	215	429	644	857	1069	1280	1489	52
54	0	205	411	615	818	1021	1222	1422	54
56	0	195	390	585	778	971	1162	1353	56
58	0	185	370	554	738	920	1102	1282	58
60	0	175	349	523	696	868	1040	1210	**60**
62	0	164	328	490	653	815	976	1136	62
64	0	153	306	458	610	761	911	1060	64
66	0	142	284	425	566	706	846	984	66
68	0	131	261	392	521	651	779	906	68
70	0	119	239	358	476	594	711	827	**70**
72	0	108	216	323	430	537	643	748	72
74	0	96	192	288	384	479	573	667	74
76	0	84	169	253	337	420	503	585	76
78	0	73	145	217	289	361	432	503	78
80	0	61	121	182	242	302	361	420	**80**
82	0	49	97	146	194	242	289	337	82
84	0	36	73	109	146	182	217	253	84
86	0	24	49	73	97	121	145	169	86
88	0	12	24	36	49	61	73	84	88
Use these in Fore-noon →	0° 180	2° 178	4° 176	6° 174	8° 172	10° 170	12° 168	14° 166	← Use these in Fore-noon
Use these in After-noon →	180° 360	182° 358	184° 356	186° 354	188° 352	190° 350	192° 348	194° 346	← Use these in After-noon
	True Bearing or Azimuth								

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-angle for a Star Observation							
Use these in Fore-noon →	13h 4m 22 56	13h 12m 22 48	13h 20m 22 40	13h 28m 22 32	13h 36m 22 24	13h 44m 22 16	13h 52m 22 8	← Use these in Fore-noon
Use these in After-noon →	1h 4m 10 56	1h 12m 10 48	1h 20m 10 40	1h 28m 10 32	1h 36m 10 24	1h 44m 10 16	1h 52m 10 8	← Use these in After-noon
Declinations								Altitudes
0°	2756	3090	3421	3746	4067	4383	4695	0°
2	2755	3088	3418	3744	4065	4381	4692	2
4	2750	3082	3412	3737	4058	4373	4684	4
6	2742	3073	3402	3726	4044	4360	4669	6
8	2730	3060	3387	3710	4028	4341	4649	8
10	2714	3043	3368	3689	4005	4317	4624	**10**
12	2696	3023	3346	3664	3978	4287	4592	12
14	2674	2998	3319	3635	3947	4253	4555	14
16	2650	2970	3288	3600	3910	4214	4513	16
18	2622	2939	3253	3563	3868	4170	4465	18
20	2590	2903	3214	3521	3821	4119	4412	**20**
22	2556	2865	3171	3473	3771	4064	4353	22
24	2519	2823	3125	3422	3715	4005	4288	24
26	2477	2777	3074	3367	3656	3941	4220	26
28	2434	2729	3020	3308	3591	3871	4145	28
30	2387	2676	2962	3244	3522	3796	4065	**30**
32	2337	2620	2900	3177	3449	3718	3981	32
34	2285	2563	2835	3106	3372	3634	3892	34
36	2230	2500	2767	3031	3291	3546	3798	36
38	2172	2435	2696	2952	3205	3454	3699	38
40	2112	2367	2620	2869	3116	3358	3596	**40**
42	2048	2297	2542	2784	3023	3258	3489	42
44	1983	2223	2460	2695	2925	3154	3377	44
46	1914	2147	2375	2602	2826	3045	3261	46
48	1845	2067	2289	2507	2721	2934	3142	48
50	1772	1986	2199	2408	2614	2818	3018	**50**
52	1697	1902	2106	2306	2504	2699	2891	52
54	1620	1818	2010	2202	2391	2577	2759	54
56	1541	1728	1913	2094	2275	2451	2625	56
58	1461	1638	1812	1986	2155	2324	2488	58
60	1378	1545	1710	1874	2033	2192	2347	**60**
62	1294	1451	1606	1759	1909	2058	2204	62
64	1209	1355	1499	1643	1783	1922	2058	64
66	1121	1257	1391	1524	1654	1783	1909	66
68	1032	1158	1281	1404	1524	1643	1759	68
70	943	1057	1169	1281	1391	1499	1606	**70**
72	852	955	1057	1158	1257	1355	1451	72
74	760	852	943	1032	1121	1209	1294	74
76	667	748	827	906	984	1060	1136	76
78	573	643	711	779	846	911	976	78
80	479	537	594	651	706	761	815	**80**
82	384	430	476	521	566	610	653	82
84	288	323	358	392	425	458	491	84
86	192	216	239	261	290	306	328	86
88	96	108	119	131	142	153	164	88
Use these in Fore-noon →	16° 164	18° 162	20° 160	22° 158	24° 156	26° 154	28° 152	← Use these in Fore-noon
Use these in After-noon →	196° 344	198° 342	200° 340	202° 338	204° 336	206° 334	208° 332	← Use these in After-noon
	True Bearing or Azimuth							

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-Angle for a Star Observation								
Use these in Forenoon →	$14^h\ 0^m$ 22 0	$14^h\ 8^m$ 21 52	$14^h\ 16^m$ 21 44	$14^h\ 24^m$ 21 36	$14^h\ 32^m$ 21 28	$14^h\ 40^m$ 21 20	$14^h\ 48^m$ 21 12	$14^h\ 56^m$ 21 4	← Use these in Forenoon
Use these in Afternoon →	$2^h\ 0^m$ 10 0	$2^h\ 8^m$ 9 52	$2^h\ 16^m$ 9 44	$2^h\ 24^m$ 9 36	$2^h\ 32^m$ 9 28	$2^h\ 40^m$ 9 20	$2^h\ 48^m$ 9 12	$2^h\ 56^m$ 9 4	← Use these in Afternoon
Declinations									Altitudes
0°	5000	5299	5593	5878	6156	6428	6691	6947	**0°**
2	4997	5297	5589	5875	6153	6424	6688	6942	2
4	4987	5286	5578	5864	6142	6412	6676	6929	4
6	4973	5270	5562	5845	6124	6393	6655	6908	6
8	4951	5248	5538	5821	6096	6365	6627	6879	8
10	4923	5219	5507	5789	6063	6330	6591	6841	**10**
12	4891	5183	5470	5749	6022	6288	6545	6795	12
14	4852	5141	5426	5703	5973	6237	6492	6741	14
16	4806	5094	5375	5650	5919	6179	6433	6677	16
18	4755	5040	5319	5590	5856	6113	6363	6607	18
20	4699	4979	5255	5524	5785	6040	6288	6528	**20**
22	4635	4914	5184	5450	5709	5960	6204	6440	22
24	4567	4841	5109	5370	5624	5872	6112	6346	24
26	4493	4763	5025	5283	5534	5777	6015	6243	26
28	4415	4678	4938	5190	5437	5675	5907	6134	28
30	4330	4588	4843	5091	5332	5567	5794	6016	**30**
32	4240	4493	4742	4984	5222	5451	5674	5891	32
34	4145	4393	4635	4873	5104	5328	5547	5758	34
36	4044	4287	4524	4755	4980	5200	5414	5619	36
38	3941	4176	4407	4633	4852	5065	5272	5474	38
40	3830	4060	4284	4503	4717	4923	5126	5321	**40**
42	3715	3939	4156	4368	4575	4776	4973	5162	42
44	3596	3812	4023	4229	4429	4624	4812	4997	44
46	3473	3681	3885	4083	4277	4465	4648	4825	46
48	3346	3546	3742	3932	4120	4301	4477	4648	48
50	3214	3406	3594	3779	3958	4131	4301	4465	**50**
52	3078	3263	3443	3619	3790	3958	4120	4277	52
54	2939	3115	3287	3454	3619	3779	3932	4083	54
56	2796	2963	3127	3287	3443	3594	3742	3885	56
58	2650	2808	2963	3115	3263	3406	3546	3681	58
60	2500	2650	2796	2939	3078	3214	3346	3473	**60**
62	2347	2488	2625	2760	2891	3018	3142	3261	62
64	2192	2324	2451	2577	2699	2818	2934	3045	64
66	2033	2155	2275	2391	2504	2614	2721	2826	66
68	1874	1986	2094	2202	2306	2408	2507	2602	68
70	1710	1812	1913	2010	2106	2199	2289	2375	**70**
72	1545	1638	1728	1817	1902	1986	2067	2147	72
74	1378	1461	1541	1620	1697	1720	1845	1914	74
76	1210	1282	1353	1422	1489	1555	1619	1681	76
78	1040	1102	1162	1222	1280	1337	1391	1444	78
80	868	920	971	1021	1069	1116	1162	1206	**80**
82	696	738	778	818	857	895	931	967	82
84	523	554	585	615	644	672	699	726	84
86	349	370	390	411	429	448	467	485	86
88	175	185	195	205	215	224	234	242	88
Use these in Forenoon →	30° 150	32° 148	34° 146	36° 144	38° 142	40° 140	42° 138	44° 136	← Use these in Forenoon
Use these in Afternoon →	210° 330	212° 328	214° 326	216° 324	218° 322	220° 320	222° 318	224° 316	← Use these in Afternoon
	True Bearing or Azimuth								

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-angle for a Star Observation							
Use these in Forenoon →	$15^h\ 4^m$ 20 56	$15^h\ 12^m$ 20 48	$15^h\ 20^m$ 20 40	$15^h\ 28^m$ 20 32	$15^h\ 36^m$ 20 24	$15^h\ 44^m$ 20 16	$15^h\ 52^m$ 20 8	← Use these in Forenoon
Use these in Afternoon →	$3^h\ 4^m$ 8 56	$3^h\ 12^m$ 8 48	$3^h\ 20^m$ 8 40	$3^h\ 28^m$ 8 32	$3^h\ 36^m$ 8 24	$3^h\ 44^m$ 8 16	$3^h\ 52^m$ 8 8	← Use these in Afternoon
Declinations								Altitudes
0°	7193	7432	7661	7879	8091	8290	8480	**0°**
2	7190	7427	7656	7875	8085	8285	8476	2
4	7176	7413	7642	7861	8071	8269	8461	4
6	7153	7391	7619	7836	8046	8245	8433	6
8	7124	7358	7586	7803	8011	8210	8399	8
10	7084	7318	7544	7761	7968	8164	8352	**10**
12	7036	7269	7494	7707	7914	8110	8284	12
14	6979	7211	7433	7645	7850	8044	8228	14
16	6915	7144	7364	7575	7776	7969	8153	16
18	6841	7068	7286	7494	7695	7884	8065	18
20	6759	6984	7197	7404	7603	7791	7969	**20**
22	6670	6890	7103	7307	7501	7686	7863	22
24	6572	6789	6998	7199	7391	7573	7749	24
26	6466	6679	6885	7082	7271	7450	7623	26
28	6352	6561	6764	6958	7144	7319	7489	28
30	6230	6436	6634	6825	7006	7180	7345	**30**
32	6101	6302	6497	6683	6861	7031	7191	32
34	5964	6160	6351	6533	6707	6873	7031	34
36	5820	6012	6197	6375	6545	6707	6861	36
38	5669	5856	6037	6210	6375	6533	6683	38
40	5511	5693	5868	6037	6197	6351	6497	**40**
42	5346	5522	5693	5856	6012	6160	6302	42
44	5175	5346	5511	5669	5820	5964	6101	44
46	4997	5162	5321	5474	5619	5758	5891	46
48	4812	4973	5126	5272	5414	5547	5674	48
50	4624	4776	4923	5065	5200	5328	5451	**50**
52	4429	4575	4717	4852	4980	5104	5222	52
54	4229	4368	4503	4633	4755	4873	4984	54
56	4023	4156	4284	4407	4524	4635	4742	56
58	3812	3939	4060	4176	4287	4393	4493	58
60	3596	3715	3830	3941	4044	4145	4240	**60**
62	3378	3489	3596	3700	3798	3892	3981	62
64	3154	3258	3358	3454	3546	3634	3718	64
66	2925	3023	3116	3205	3291	3372	3449	66
68	2695	2784	2869	2952	3031	3106	3177	68
70	2460	2542	2620	2696	2767	2835	2900	**70**
72	2223	2297	2367	2435	2500	2563	2620	72
74	1983	2048	2112	2172	2230	2285	2337	74
76	1740	1798	1853	1906	1957	2005	2051	76
78	1496	1545	1592	1639	1682	1724	1763	78
80	1249	1290	1330	1369	1405	1440	1472	**80**
82	1001	1034	1066	1096	1126	1153	1180	82
84	752	777	801	824	846	867	886	84
86	502	518	534	550	564	578	592	86
88	251	259	267	275	282	289	296	88
Use these in Forenoon →	46° 134	48° 132	50° 130	52° 128	54° 126	56° 124	58° 122	← Use these in Forenoon
Use these in Afternoon →	226° 314	228° 312	230° 310	232° 308	234° 306	236° 304	238° 302	← Use these in Afternoon
	True Bearing or Azimuth							

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-angle for a Star Observation								
Use these in Fore-noon →	$16^h\ 0^m$	$16^h\ 8^m$	$16^h\ 16^m$	$16^h\ 24^m$	$16^h\ 32^m$	$16^h\ 40^m$	$16^h\ 48^m$	$16^h\ 56^m$	← Use these in Fore-noon
	20 0	19 52	19 44	19 36	19 28	19 20	19 12	19 4	
Use these in After-noon →	$4^h\ 0^m$	$4^h\ 8^m$	$4^h\ 16^m$	$4^h\ 24^m$	$4^h\ 32^m$	$4^h\ 40^m$	$4^h\ 48^m$	$4^h\ 56^m$	→ Use these in After-noon
	8 0	7 52	7 44	7 36	7 28	7 20	7 12	7 4	
Declinations									**Altitudes**
0°	8660	8828	8989	9135	9272	9397	9510	9612	**0°**
2	8656	8824	8982	9131	9266	9391	9506	9607	2
4	8640	8808	8966	9114	9249	9374	9486	9590	4
6	8612	8780	8939	9084	9221	9346	9458	9561	6
8	8576	8744	8900	9046	9181	9305	9419	9519	8
10	8529	8696	8851	8997	9131	9253	9367	9466	**10**
12	8470	8636	8792	8935	9069	9191	9303	9401	12
14	8403	8567	8722	8863	8997	9118	9228	9326	14
16	8326	8487	8640	8782	8913	9033	9143	9241	16
18	8235	8397	8549	8688	8818	8937	9044	9143	18
20	8137	8296	8447	8584	8714	8831	8937	9033	**20**
22	8030	8187	8333	8470	8596	8714	8818	8913	22
24	7912	8067	8212	8347	8470	8584	8688	8782	24
26	7784	7936	8078	8212	8333	8447	8549	8640	26
28	7647	7796	7936	8067	8187	8296	8397	8487	28
30	7501	7647	7784	7912	8030	8137	8235	8326	**30**
32	7345	7489	7623	7749	7863	7969	8065	8153	32
34	7180	7319	7450	7573	7686	7791	7884	7969	34
36	7006	7144	7271	7391	7501	7603	7695	7776	36
38	6825	6958	7082	7199	7307	7404	7494	7575	38
40	6634	6764	6885	6998	7103	7197	7286	7364	**40**
42	6436	6561	6679	6789	6890	6984	7068	7144	42
44	6230	6352	6466	6572	6670	6759	6841	6915	44
46	6016	6134	6243	6346	6440	6528	6607	6677	46
48	5794	5907	6015	6212	6204	6288	6363	6433	48
50	5567	5675	5777	5872	5960	6040	6113	6179	**50**
52	5332	5437	5534	5624	5709	5785	5856	5919	52
54	5091	5190	5283	5370	5450	5524	5590	5650	54
56	4843	4938	5025	5109	5184	5255	5319	5375	56
58	4588	4678	4763	4841	4914	4979	5040	5094	58
60	4330	4415	4493	4567	4635	4699	4755	4806	**60**
62	4065	4145	4220	4288	4353	4412	4465	4513	62
64	3796	3871	3941	4005	4064	4119	4170	4214	64
66	3522	3591	3656	3715	3771	3821	3868	3910	66
68	3244	3308	3367	3422	3473	3521	3563	3600	68
70	2962	3020	3074	3125	3171	3214	3253	3288	**70**
72	2676	2729	2777	2823	2865	2903	2939	2970	72
74	2387	2434	2477	2519	2556	2590	2622	2650	74
76	2095	2136	2174	2210	2244	2274	2301	2326	76
78	1801	1835	1868	1900	1928	1954	1977	1998	78
80	1504	1533	1561	1586	1610	1632	1651	1669	**80**
82	1205	1228	1251	1272	1290	1308	1323	1338	82
84	905	923	940	955	969	982	994	1005	84
86	604	616	627	637	647	656	663	671	86
88	302	308	314	319	324	328	332	336	88
Use these in Fore-noon →	60°	62°	64°	66°	68°	70°	72°	74°	← Use these in Fore-noon
	120	118	116	114	112	110	108	106	
Use these in After-noon →	240°	242°	244°	246°	248°	250°	252°	254°	← Use these in After-noon
	300	298	296	294	292	290	288	286	
	True Bearing or Azimuth								

	T, The Ship's Apparent Time for a Sun Observation, or the Hour-angle for a Star Observation								
Use these in Fore-noon →	$17^h\ 4^m$ 18 56	$17^h\ 12^m$ 18 48	$17^h\ 20^m$ 18 40	$17^h\ 28^m$ 18 32	$17^h\ 36^m$ 18 24	$17^h\ 44^m$ 18 16	$17^h\ 52^m$ 18 8	$18^h\ 0^m$ 18 0	← Use these in Fore-noon
Use these in After-noon →	$5^h\ 4^m$ 6 56	$5^h\ 12^m$ 6 48	$5^h\ 20^m$ 6 40	$5^h\ 28^m$ 6 32	$5^h\ 36^m$ 6 24	$5^h\ 44^m$ 6 16	$5^h\ 52^m$ 6 8	$6^h\ 0^m$ 6 0	← Use these in After-noon
Declinations									Altitudes
0°	9703	9781	9849	9904	9945	9974	9993	10000	**0°**
2	9696	9774	9842	9897	9940	9970	9988	9993	2
4	9679	9757	9824	9879	9922	9951	9970	9974	4
6	9649	9727	9795	9849	9891	9922	9940	9945	6
8	9610	9687	9752	9806	9849	9879	9897	9904	8
10	9557	9634	9699	9752	9795	9824	9842	9849	**10**
12	9491	9568	9634	9687	9727	9757	9774	9781	12
14	9414	9491	9557	9610	9649	9679	9696	9703	14
16	9326	9401	9466	9519	9561	9590	9607	9612	16
18	9228	9303	9367	9419	9458	9486	9506	9510	18
20	9118	9191	9253	9305	9346	9374	9391	9397	**20**
22	8997	9069	9131	9181	9221	9249	9266	9272	22
24	8863	8935	8997	9046	9084	9114	9131	9135	24
26	8722	8792	8851	8900	8939	8966	8982	8989	26
28	8567	8636	8696	8744	8780	8808	8824	8828	28
30	8403	8470	8529	8576	8612	8640	8656	8660	**30**
32	8228	8284	8352	8399	8433	8461	8476	8480	32
34	8044	8110	8164	8210	8245	8269	8285	8290	34
36	7850	7914	7968	8011	8046	8071	8085	8091	36
38	7645	7707	7761	7803	7836	7861	7875	7879	38
40	7433	7494	7544	7586	7619	7642	7656	7661	**40**
42	7211	7269	7318	7358	7391	7413	7427	7432	42
44	6979	7036	7084	7124	7153	7176	7190	7193	44
46	6741	6795	6841	6879	6908	6929	6942	6947	46
48	6492	6545	6591	6627	6655	6676	6688	6691	48
50	6237	6288	6330	6365	6393	6412	6424	6428	**50**
52	5973	6022	6063	6096	6124	6142	6153	6156	52
54	5703	5749	5789	5821	5845	5864	5875	5878	54
56	5426	5470	5507	5538	5562	5578	5589	5593	56
58	5141	5183	5219	5248	5270	5286	5297	5299	58
60	4852	4891	4923	4951	4973	4987	4997	5000	**60**
62	4555	4592	4624	4649	4669	4684	4692	4695	62
64	4253	4287	4317	4341	4360	4373	4381	4383	64
66	3947	3978	4005	4028	4044	4058	4065	4067	66
68	3635	3664	3689	3710	3726	3737	3744	3746	68
70	3319	3346	3368	3387	3402	3412	3418	3421	**70**
72	2998	3023	3043	3060	3073	3082	3088	3090	72
74	2674	2696	2714	2730	2742	2750	2755	2756	74
76	2347	2367	2382	2395	2406	2413	2417	2419	76
78	2018	2033	2047	2059	2067	2074	2078	2079	78
80	1685	1698	1710	1720	1726	1732	1736	1737	**80**
82	1351	1361	1371	1378	1384	1389	1391	1392	82
84	1015	1022	1029	1035	1040	1042	1045	1045	84
86	677	682	687	691	694	696	697	698	86
88	339	341	344	346	347	348	349	349	88
Use these in Fore-noon →	76° 104	78° 102	80° 100	82° 98	84° 96	86° 94	88° 92	90° 90	← Use these in Fore-noon
Use these in After-noon →	256° 284	258° 282	260° 280	262° 278	264° 276	266° 274	268° 272	270° 270	← Use these in After-noon
	True Bearing or Azimuth								

Latitude	Declinations												
	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°
0°	0°												
2	0	90°											
4	0	30	90°										
6	0	20	42	90°									
8	0	15	30	49	90°								
10	0	12	24	37	53	90°							
12	0	10	20	30	42	57	90°						
14	0	8	17	26	35	46	59	90°					
16	0	7	15	22	30	39	49	61	90°				
18	0	6	13	20	27	34	42	52	63	90°			
20	0	6	12	18	24	31	37	45	54	65	90°		
22	0	5	11	16	22	28	34	40	47	56	66	90°	
24	0	5	10	15	20	25	31	36	43	49	57	67	90°
26	0	5	9	14	19	23	28	34	39	45	51	59	68
28	0	4	9	13	17	22	26	31	36	41	47	53	60
30	0	4	8	12	16	20	25	29	33	38	43	49	54
32	0	4	8	11	15	19	23	27	31	36	40	45	50
34	0	4	7	11	14	18	22	26	30	34	38	42	47
36	0	3	7	10	14	17	21	24	28	32	36	40	44
38	0	3	7	10	13	16	20	23	27	30	34	37	41
40	0	3	6	9	12	16	19	22	25	29	32	36	39
42	0	3	6	9	12	15	18	21	24	28	31	34	37
44	0	3	6	9	12	14	17	20	23	26	30	33	36
46	0	3	6	8	11	14	17	20	23	25	28	31	34
48	0	3	5	8	11	14	16	19	22	25	27	30	33
50	0	3	5	8	10	13	16	18	21	24	27	29	32
52	0	3	5	8	10	13	15	18	20	23	26	28	31
54	0	2	5	7	10	12	15	17	20	22	25	28	30
56	0	2	5	7	10	12	15	17	19	22	24	27	29
58	0	2	5	7	9	12	14	17	19	21	24	26	29
60	0	2	5	7	9	12	14	16	19	21	23	26	28

Table 12. Completed

Latitude	Declinations												
	26°	28°	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°
26°	90°												
28	69	90°											
30	61	70	90°										
32	56	62	71	90°									
34	52	57	63	71	90°								
36	48	53	58	64	72	90°							
38	45	50	54	59	65	73	90°						
40	43	47	51	56	60	66	73	90°					
42	41	45	48	53	57	61	67	74	90°				
44	39	43	46	50	54	58	62	68	74	90°			
46	38	41	44	47	51	55	59	63	68	75	90°		
48	36	39	42	45	49	52	56	60	64	69	75	90°	
50	35	38	41	44	47	50	53	57	61	65	70	76	90°
52	34	37	39	42	45	48	51	55	58	62	66	71	76
54	33	35	38	41	44	47	50	53	56	59	63	67	71
56	32	34	37	40	42	45	48	51	54	57	60	64	68
58	31	33	36	39	41	44	47	49	52	55	58	61	65
60	30	33	35	38	40	43	45	48	51	53	56	59	62

b	a = 0°		a = 1°		a = 2°		a = 3°		a = 4°		a = 5°		a = 6°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	0 0	0 0	1 0	0 0	2 0	0 0	3 0	0 0	4 0	0 0	5 0	0 0	6 0
1	1 0	0	1 0	0	1 0	0	1 0	0	1 0	0	1 0	0	1 0	0
2	2 0	0	2 0	0	2 0	0	2 0	0	2 0	0	2 0	0	59	0
3	3 0	0	3 0	0	3 0	0	3 0	0	3 0	0	59	0	2 59	0
4	4 0	0	4 0	0	4 0	0	4 0	0	59	1	3 59	1	3 59	1
5	5 0	0	5 0	0	5 0	0	5 0	1	4 59	1	4 59	1	4 58	1
6	6 0	0	6 0	0	6 0	1	6 0	1	5 59	1	5 59	2	5 58	2
7	7 0	0	7 0	0	7 0	1	59	1	6 59	2	6 58	2	6 58	3
8	8 0	0	8 0	1	8 0	1	7 59	2	7 59	2	7 58	3	7 57	4
9	9 0	0	9 0	1	9 0	1	8 59	2	8 59	3	8 58	4	8 57	5
10	10 0	0	10 0	1	10 0	2	9 59	3	9 59	4	9 58	5	9 57	6
11	11 0	0	11 0	1	11 0	2	10 59	3	10 58	4	10 57	6	10 56	7
12	12 0	0	12 0	1	12 0	3	11 59	4	11 58	5	11 57	7	11 56	8
13	13 0	0	13 0	2	13 0	3	12 59	5	12 58	6	12 57	8	12 56	9
14	14 0	0	14 0	2	59	4	13 59	5	13 58	7	13 57	9	13 55	11
15	15 0	0	15 0	2	14 59	4	14 59	6	14 58	8	14 56	10	14 55	13
16	16 0	0	16 0	2	15 59	5	15 59	7	15 58	10	15 56	12	15 55	14
17	17 0	0	17 0	3	16 59	5	16 59	8	16 57	11	16 56	14	16 54	16
18	18 0	0	18 0	3	17 59	6	17 58	9	17 57	12	17 56	15	17 54	18
19	19 0	0	19 0	3	18 59	7	18 58	10	18 57	14	18 55	17	18 54	21
20	20 0	0	20 0	4	19 59	8	19 58	11	19 57	15	19 55	19	19 53	23
21	21 0	0	21 0	4	20 59	9	20 58	13	20 57	17	20 55	21	20 53	25
22	22 0	0	22 0	5	21 59	9	21 58	14	21 57	19	21 55	23	21 52	28
23	23 0	0	23 0	5	22 59	10	22 58	15	22 56	21	22 54	26	22 52	31
24	24 0	0	24 0	6	23 59	11	23 58	17	23 56	23	23 54	28	23 52	34
25	25 0	0	25 0	6	24 59	12	24 58	18	24 56	25	24 54	31	24 51	37
26	26 0	0	26 0	7	25 59	13	25 58	20	25 56	27	25 54	34	25 51	40
27	27 0	0	27 0	7	26 59	15	26 58	22	26 56	29	26 53	37	26 50	44
28	28 0	0	28 0	8	27 59	16	27 57	24	27 56	32	27 53	40	27 50	47
29	29 0	0	29 0	9	28 59	17	28 57	26	28 55	34	28 53	43	28 50	51
30	30 0	0	30 0	9	29 59	19	29 57	28	29 55	37	29 52	46	29 49	55
31	31 0	0	31 0	10	30 59	20	30 57	30	30 55	40	30 52	50	30 49	59
32	32 0	0	32 0	11	31 59	21	31 57	32	31 55	43	31 52	53	31 48	7 4
33	33 0	0	33 0	12	32 59	23	32 57	34	32 55	46	32 52	57	32 48	9
34	34 0	0	34 0	12	33 59	25	33 57	37	33 54	49	33 51	6 1	33 47	14
35	35 0	0	35 0	13	34 59	26	34 57	40	34 54	53	34 51	6	34 47	19
36	36 0	0	36 0	14	35 58	28	35 57	42	35 54	56	35 51	10	35 46	24
37	37 0	0	37 0	15	36 58	30	36 56	45	36 54	5 0	36 50	15	36 46	30
38	38 0	0	38 0	16	37 58	32	37 56	48	37 53	4	37 50	20	37 45	36
39	39 0	0	39 0	17	38 58	34	38 56	51	38 53	8	38 49	25	38 45	42
40	40 0	0	40 0	18	39 58	37	39 56	55	39 53	13	39 49	31	39 44	49
41	41 0	0	41 0	19	40 58	39	40 56	58	40 53	18	40 49	37	40 44	56
42	42 0	0	42 0	21	41 58	41	41 56	4 2	41 52	23	41 48	43	41 43	8 3
43	43 0	0	43 0	22	42 58	44	42 56	6	42 52	28	42 48	49	42 42	11
44	44 0	0	59	23	43 58	47	43 55	10	43 52	33	43 47	56	43 42	19
45	45 0	0	44 59	25	44 58	50	44 55	14	44 52	39	44 47	7 3	44 41	27

b	a = 0°		a = 1°		a = 2°		a = 3°		a = 4°		a = 5°		a = 6°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	45 0	0 0	44 59	1 25	44 58	2 50	44 55	4 14	44 52	5 39	44 47	7 3	44 41	8 27
46	46 0	0	45 59	26	45 58	53	45 55	19	45 51	45	45 46	11	45 41	36
47	47 0	0	46 59	28	46 58	56	46 55	24	46 51	51	46 46	19	46 40	46
48	48 0	0	47 59	30	47 58	59	47 55	29	47 51	58	47 45	27	47 39	56
49	49 0	0	48 59	31	48 58	3 3	48 55	34	48 50	6 5	48 45	36	48 38	9 6
50	50 0	0	49 59	33	49 58	7	49 54	40	49 50	13	49 44	45	49 38	17
51	51 0	0	50 59	35	50 57	11	50 54	46	50 50	21	50 44	55	50 37	29
52	52 0	0	51 59	37	51 57	15	51 54	52	51 49	29	51 43	8 5	51 36	41
53	53 0	0	52 59	40	52 57	19	52 54	59	52 49	38	52 43	16	52 35	54
54	54 0	0	53 59	42	53 57	24	53 54	5 6	53 49	47	53 42	28	53 34	10 8
55	55 0	0	54 59	45	54 57	29	54 53	13	54 48	57	54 41	40	54 33	23
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88	52	82 2	52	82 35	53	83 4	53	83 29	54	83 52	54	84 13	54	84 31
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90	76 0	90 0	75 0	90 0	74 0	90 0	73 0	90 0	72 0	90 0	71 0	90 0	70 0	90 0

b	a = 21°		a = 22°		a = 23°		a = 24°		a = 25°		a = 26°		a = 27°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	21 0	0 0	22 0	0 0	23 0	0 0	24 0	0 0	25 0	0 0	26 0	0 0	27 0
1	56	0	56	0	55	0	55	0	54	0	54	0	53	0
2	1 52	1	1 51	1	1 51	1	1 50	1	1 49	1	1 48	1	1 47	1
3	2 48	2	2 47	2	2 46	2	2 44	2	2 43	2	2 42	2	2 40	2
4	3 44	3	3 42	3	3 41	3	3 39	3	3 38	3	3 36	3	3 34	3
5	4 40	4	4 38	5	4 36	5	4 34	5	4 32	5	4 30	5	4 27	5
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9	8 24	14	8 20	15	8 17	15	8 13	16	8 9	16	8 5	17	8 1	17
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16	14 55	46	14 48	48	14 42	49	14 35	51	14 28	53	14 21	54	14 13	56
17	15 50	52	15 44	54	15 37	56	15 29	58	15 22	26 0	15 14	27 1	15 6	28 3
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23	21 24	38	21 14	42	21 5	45	55	49	20 44	52	20 33	55	20 22	58
24	22 19	47	22 9	52	59	55	21 49	59	21 38	27 3	21 26	28 6	21 15	29 9
25	23 14	57	23 4	24 2	22 54	25 6	22 43	26 10	22 31	14	22 19	17	22 7	21
26	24 9	23 8	59	12	23 48	17	23 37	21	23 25	25	23 12	29	23 0	33
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43	39 33	42	39 13	55	53	30 8	38 32	31 20	38 11	31	37 48	42	37 25	52
44	40 26	28 5	40 6	29 19	39 45	33	39 23	45	39 1	57	38 38	34 8	38 14	35 19
45	41 19	30	58	44	40 37	59	40 14	32 12	51	33 24	39 28	36	39 3	47

b	a = 21° K	a = 21° Q	a = 22° K	a = 22° Q	a = 23° K	a = 23° Q	a = 24° K	a = 24° Q	a = 25° K	a = 25° Q	a = 26° K	a = 26° Q	a = 27° K	a = 27° Q
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51	46 31	31 23	46 6	42	45 40	34 0	45 14	35 17	44 47	36 32	44 18	46	49	39 0
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53	48 13	32 32	47 46	53	47 19	35 12	51	36 30	46 22	46	52	39 1	45 22	40 15
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b	a = 28° K	a = 28° Q	a = 29° K	a = 29° Q	a = 30° K	a = 30° Q	a = 31° K	a = 31° Q	a = 32° K	a = 32° Q	a = 33° K	a = 33° Q	a = 34° K	a = 34° Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	28 0	0 0	29 0	0 0	30 0	0 0	31 0	0 0	32 0	0 0	33 0	0 0	34 0
1	53	0	52	0	52	0	51	0	51	0	50	0	50	0
2	1 46	1	1 45	1	1 44	1	1 43	1	1 42	1	1 41	1	1 39	1
3	2 39	2	2 37	2	2 36	2	2 34	2	2 33	2	2 31	2	2 29	2
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7	6 11	11	6 7	11	6 4	11	6 0	11	56	11	52	12	5 48	12
8	7 4	14	59	14	55	15	51	15	6 47	15	6 42	15	6 38	16
9	56	18	7 52	18	7 47	19	7 43	19	7 37	19	7 32	19	7 27	20
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11	9 42	27	9 36	27	9 31	28	9 25	28	9 19	29	9 12	29	9 6	30
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19	16 42	21	16 33	23	16 23	25	16 12	26	16 2	27	51	29	15 40	30
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23	20 11	30 1	59	31 3	19 47	32 6	19 34	33 8	19 21	34 10	19 8	12	54	14
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25	55	24	21 41	27	21 28	30	21 14	33	21 0	35	20 46	37	20 30	39
26	22 46	37	22 32	40	22 19	43	22 4	46	49	48	21 34	51	21 18	53
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32	54	32 5	27 37	33 10	27 19	34 15	27 1	19	26 42	23	26 23	27	26 3	30
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b	a = 28°		a = 29°		a = 30°		a = 31°		a = 32°		a = 33°		a = 34°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
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47	40 13	56	39 46	39 6	39 18	40 15	49	41 23	38 20	42 30	50	36	37 19	41
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63	53	49 30	51 12	50 41	50 30	51 49	48	56	49 5	54 0	48 21	55 3	37	56 4
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65	53 9	51 31	52 26	52 41	43	53 48	59	54 53	50 14	55 56	49 28	56 57	42	57 56
66	46	52 35	53 2	53 44	52 18	54 50	51 33	55 55	47	56 56	50 1	57 57	49 14	58 55
67	54 22	53 41	37	54 49	52	55 55	52 6	56 58	51 19	57 59	32	58 58	44	59 55
68	57	54 50	54 11	55 57	53 25	57 1	38	58 3	50	59 4	51 2	60 1	50 14	60 57
69	55 31	56 1	44	57 7	57	58 10	53 9	59 11	52 21	60 10	32	61 6	43	62 1
70	56 4	57 15	55 16	58 19	54 28	59 21	39	60 21	50	61 18	52 1	62 13	51 10	63 7
71	36	58 31	47	59 34	58	60 35	54 8	61 33	53 18	62 29	28	63 22	37	64 14
72	57 7	59 50	56 17	60 52	55 27	61 51	36	62 47	45	63 41	54	64 33	52 3	65 23
73	36	61 12	46	62 12	55	63 9	55 3	64 3	54 11	64 56	53 19	65 46	27	66 34
74	58 4	62 36	57 13	63 34	56 21	64 29	29	65 21	36	66 12	43	67 0	50	67 46
75	31	64 3	39	64 58	46	65 51	53	66 42	55 0	67 30	54 6	68 16	53 12	69 0
76	57	65 32	58 4	66 25	57 10	67 16	56 16	68 4	22	68 50	28	69 34	33	70 16
77	59 21	67 4	27	67 54	33	68 43	38	69 29	43	70 12	48	70 54	53	71 33
78	44	68 39	49	69 26	54	70 12	58	70 55	56 3	71 36	55 7	72 15	54 11	72 52
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81	42	73 36	45	74 14	48	74 50	51	75 24	53	75 57	56	76 27	58	76 57
82	58	75 20	60 0	75 54	59 3	76 27	58 5	76 57	57 7	77 27	56 9	77 54	55 11	78 21
83	61 12	77 6	14	77 36	16	78 5	18	78 32	19	78 58	21	79 22	22	79 46
84	25	78 53	26	79 19	28	79 44	29	80 8	30	80 30	31	80 51	32	81 12
85	36	80 42	36	81 4	38	81 25	38	81 45	39	82 4	40	82 21	41	82 38
86	44	82 32	45	82 50	46	83 7	46	83 23	47	83 38	47	83 52	48	84 6
87	51	84 23	51	84 36	52	84 49	52	85 1	53	85 13	53	85 23	53	85 34
88	56	86 15	56	86 24	56	86 32	56	86 40	57	86 48	57	86 55	57	87 2
89	59	88 7	59	88 12	59	88 16	59	88 20	59	88 24	59	88 27	59	88 31
90	62 0	90 0	61 0	90 0	60 0	90 0	59 0	90 0	58 0	90 0	57 0	90 0	56 0	90 0

b	a = 35°		a = 36°		a = 37°		a = 38°		a = 39°		a = 40°		a = 41°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	35 0	0 0	36 0	0 0	37 0	0 0	38 0	0 0	39 0	0 0	40 0	0 0	41 0
1	49	0	49	0	48	0	47	0	47	0	46	0	45	0
2	1 38	1	1 37	1	1 36	1	1 35	1	1 33	1	1 32	1	1 31	1
3	2 27	2	2 26	2	2 24	2	2 22	2	2 20	2	2 18	2	2 16	2
4	3 17	4	3 14	4	3 12	4	3 9	4	3 7	4	3 4	4	3 1	4
5	4 6	6	4 3	6	59	6	56	6	53	6	50	6	46	6
6	55	9	51	9	4 47	9	4 44	9	4 40	9	4 36	9	4 31	9
7	5 44	12	5 39	12	5 35	12	5 31	12	5 26	13	5 21	13	5 17	13
8	6 33	16	6 28	16	6 23	16	6 18	16	6 13	17	6 7	17	6 2	17
9	7 22	20	7 16	20	7 11	20	7 5	21	59	21	53	21	47	21
10	8 11	25	8 5	25	58	25	52	26	7 45	26	7 39	26	7 32	26
11	9 0	30	53	30	8 46	31	8 39	31	8 32	31	8 24	31	8 17	32
12	48	36	9 41	36	9 34	37	9 26	37	9 18	37	9 10	37	9 2	38
13	10 37	42	10 29	43	10 21	43	10 13	43	10 4	44	55	44	47	44
14	11 26	49	11 17	50	11 8	50	59	50	50	51	10 41	51	10 31	51
15	12 14	56	12 5	57	56	57	11 46	58	11 36	59	11 26	59	11 16	59
16	13 3	36 4	53	37 5	12 43	38 5	12 33	39 6	12 22	40 7	12 11	41 7	12 0	42 7
17	51	13	13 41	13	13 30	14	13 19	15	13 8	16	56	16	45	16
18	14 40	22	14 29	22	14 17	23	14 6	24	54	25	13 41	25	13 29	26
19	15 28	31	15 16	32	15 4	33	52	34	14 40	35	14 26	35	14 13	36
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21	17 4	52	51	54	16 38	55	16 24	55	16 10	56	56	57	15 41	57
22	52	37 4	17 38	38 5	17 25	39 6	17 10	40 7	55	41 8	16 41	42 9	16 25	43 9
23	18 40	16	18 25	17	18 11	18	56	19	17 40	20	17 25	21	17 9	22
24	19 28	28	19 12	30	57	31	18 42	32	18 25	33	18 9	34	53	35
25	20 15	41	59	43	19 43	45	19 27	46	19 10	47	53	48	18 36	48
26	21 3	55	20 46	57	20 29	59	20 13	41 0	55	42 1	19 37	43 2	19 19	44 3
27	50	38 10	21 33	39 12	21 15	40 13	58	15	20 40	16	20 21	17	20 2	18
28	22 37	25	22 19	27	22 1	29	21 43	30	21 24	32	21 5	33	45	33
29	23 24	41	23 5	43	47	45	22 28	46	22 8	48	48	49	21 28	49
30	24 11	57	51	40 0	23 32	41 2	23 12	42 3	52	43 5	22 31	44 6	22 10	45 6
31	57	39 15	24 37	17	24 17	19	57	21	23 36	22	23 14	23	52	24
32	25 44	33	25 23	35	25 2	37	24 41	39	24 19	41	57	42	23 34	43
33	26 30	52	26 9	54	47	56	25 25	58	25 2	44 0	24 40	45 1	24 16	46 2
34	27 16	40 11	54	41 14	26 32	42 16	26 9	43 18	45	20	25 22	21	58	22
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36	47	52	28 24	56	28 0	58	27 35	44 0	27 11	45 2	46	46 3	26 20	47 3
37	29 32	41 14	29 8	42 18	44	43 20	28 18	22	53	24	27 27	25	27 1	25
38	30 17	37	52	41	29 27	43	29 1	45	28 35	47	28 8	48	41	48
39	31 2	42 1	30 36	43 4	30 10	44 7	44	45 9	29 17	46 11	49	47 12	28 21	48 12
40	46	26	31 20	29	53	32	30 26	34	58	35	29 30	36	29 1	37
41	32 30	51	32 3	55	31 36	58	31 8	46 0	30 39	47 1	30 10	48 2	41	49 2
42	33 14	43 18	46	44 21	32 18	45 24	49	26	31 20	28	50	28	30 20	28
43	58	45	33 29	49	33 0	52	32 30	53	32 0	55	31 30	55	59	55
44	34 41	44 14	34 12	45 17	42	46 20	33 11	47 22	40	48 23	32 9	49 24	31 37	50 23
45	35 24	43	54	46	34 23	49	52	51	33 20	52	48	53	32 15	52

b	a = 35°		a = 36°		a = 37°		a = 38°		a = 39°		a = 40°		a = 41°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
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46	36 6	45 14	35 35	46 17	35 4	47 20	34 32	48 22	59	49 23	33 26	50 23	53	51 22
47	48	45	36 16	49	44	51	35 12	53	34 38	54	34 4	54	33 30	53
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49	38 11	52	37 38	55	37 4	57	36 30	59	55	59	35 19	59	43	57
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51	39 32	48 3	57	49 6	38 22	50 8	46	51 9	37 9	52 9	36 32	53 8	55	54 6
52	40 12	41	39 36	43	39 0	45	38 23	46	46	45	37 8	44	36 30	42
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55	42 9	50 41	41 30	43	52	43	40 12	43	39 32	41	52	55 39	38 11	56 35
56	47	51 23	42 7	52 25	41 28	53 25	47	54 24	40 7	55 22	39 26	56 19	44	57 15
57	43 24	52 7	43	53 9	42 3	54 8	41 22	55 7	41	56 4	59	57 1	39 16	56
58	44 0	53	43 19	54	38	53	56	51	41 14	48	40 31	44	48	58 38
59	36	53 40	54	54 40	43 12	55 39	42 29	56 36	46	57 33	41 3	58 28	40 19	59 21
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61	46	55 18	45 2	56 17	44 19	57 15	34	58 11	49	59 6	42 4	59	41 18	51
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63	53	57 3	46 7	58 0	45 22	56	36	50	50	60 43	43 3	61 35	42 15	62 25
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65	56	58 53	47 9	59 49	46 22	60 43	35	61 35	47	62 26	58	63 16	43 9	64 4
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67	56	60 50	48 8	61 44	47 19	62 36	30	63 26	40	64 15	51	65 2	44 0	65 48
68	49 25	61 51	36	62 44	46	63 34	56	64 23	46 6	65 11	45 16	57	24	66 41
69	53	62 54	49 3	63 45	48 13	64 34	47 22	65 22	31	66 8	40	66 53	48	67 36
70	50 20	63 58	29	64 48	38	65 35	46	66 22	55	67 6	46 3	67 50	45 10	68 31
71	46	65 4	54	65 52	49 2	66 38	48 10	67 23	47 17	68 6	25	68 48	32	69 28
72	51 10	66 11	50 18	66 58	26	67 42	33	68 25	39	69 7	46	69 47	52	70 26
73	34	67 20	41	68 5	48	68 48	54	69 29	48 0	70 9	47 6	70 47	46 12	71 25
74	57	68 31	51 3	69 14	50 9	69 55	49 15	70 34	20	71 12	26	71 49	30	72 25
75	52 18	69 43	24	70 24	29	71 3	34	71 40	39	72 16	44	72 51	48	73 25
76	38	70 56	43	71 35	48	72 12	52	72 48	57	73 22	48 1	73 55	47 5	74 27
77	57	72 11	52 1	72 48	51 6	73 23	50 9	73 56	49 13	74 29	17	75 0	20	75 30
78	53 15	73 28	18	74 2	22	74 35	25	75 6	29	75 36	32	76 5	35	76 33
79	31	74 45	34	75 17	37	75 47	40	76 17	43	76 45	46	77 11	48	77 37
80	46	76 4	49	76 33	51	77 1	54	77 28	56	77 54	58	78 18	48 0	78 42
81	54 0	77 24	53 2	77 51	52 4	78 16	51 6	78 41	50 8	79 4	49 10	79 26	12	79 48
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83	24	80 8	25	80 29	26	80 49	27	81 8	29	81 27	29	81 44	31	82 1
84	33	81 31	34	81 49	35	82 6	36	82 23	37	82 39	37	82 54	39	83 9
85	41	82 54	42	83 10	43	83 24	43	83 38	44	83 52	44	84 4	45	84 17
86	48	84 19	49	84 31	49	84 43	49	84 54	50	85 5	50	85 15	50	85 25
87	53	85 44	54	85 53	54	86 2	54	86 10	54	86 18	54	86 26	54	86 33
88	57	87 9	57	87 15	57	87 21	57	87 26	57	87 32	57	87 37	57	87 42
89	59	88 34	59	88 37	59	88 40	59	88 43	59	88 46	59	88 48	59	88 51
90	55 0	90 0	54 0	90 0	53 0	90 0	52 0	90 0	51 0	90 0	50 0	90 0	49 0	90 0

b	a = 42° K	a = 42° Q	a = 43° K	a = 43° Q	a = 44° K	a = 44° Q	a = 45° K	a = 45° Q	a = 46° K	a = 46° Q	a = 47° K	a = 47° Q	a = 48° K	a = 48° Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	42 0	0 0	43 0	0 0	44 0	0 0	45 0	0 0	46 0	0 0	47 0	0 0	48 0
1	45	0	44	0	43	0	42	0	42	0	41	0	40	0
2	1 29	1	1 28	1	1 26	1	1 25	1	1 23	1	1 22	1	1 20	1
3	2 14	2	2 12	2	2 10	2	2 7	2	2 5	2	2 3	2	2 0	2
4	58	4	55	4	53	4	50	4	47	4	44	4	40	4
5	3 43	6	3 39	6	3 36	6	3 32	6	3 28	6	3 25	6	3 20	6
6	4 27	9	4 23	9	4 19	9	4 14	9	4 10	9	4 5	9	4 0	9
7	5 12	13	5 7	13	5 2	13	57	13	51	13	46	13	40	13
8	56	17	51	17	45	17	5 39	17	5 33	17	5 27	17	5 20	17
9	6 41	21	6 34	21	6 28	21	6 21	21	6 14	21	6 7	21	6 0	21
10	7 25	26	7 18	26	7 11	26	7 3	26	56	26	48	26	40	26
11	8 9	32	8 1	32	53	32	45	32	7 37	32	7 29	32	7 20	32
12	53	38	45	38	8 36	38	8 27	38	8 18	38	8 9	38	8 0	38
13	9 37	45	9 28	45	9 19	45	9 9	45	59	45	49	45	39	44
14	10 21	52	10 11	52	10 1	52	51	52	9 40	52	9 30	52	9 19	51
15	11 5	59	55	44 0	44	45 0	10 33	46 0	10 21	47 0	10 10	48 0	58	59
16	49	43 8	11 38	8	11 26	8	11 15	8	11 2	8	50	8	10 38	49 7
17	12 33	17	12 21	17	12 8	17	56	17	43	17	11 30	17	11 17	16
18	13 17	26	13 4	26	50	26	12 37	26	12 24	26	12 10	26	56	25
19	14 0	36	46	36	13 32	36	13 18	36	13 4	36	50	36	12 35	35
20	44	47	14 29	47	14 14	47	59	47	45	47	13 29	46	13 14	46
21	15 27	58	15 12	58	56	58	14 40	58	14 25	58	14 9	57	53	57
22	16 10	44 10	54	45 10	15 38	46 10	15 21	47 10	15 5	48 10	48	49 9	14 31	50 9
23	53	22	16 36	22	16 19	22	16 2	22	45	22	15 27	21	15 9	21
24	17 36	35	17 18	35	17 1	35	43	35	16 25	35	16 6	34	47	34
25	18 19	49	18 0	49	42	49	17 23	49	17 5	49	45	48	16 25	47
26	19 1	45 3	42	46 3	18 23	47 3	18 3	48 3	44	49 3	17 24	50 2	17 3	51 1
27	43	18	19 24	18	19 4	18	43	18	18 23	17	18 2	17	41	16
28	20 25	34	20 5	34	44	34	19 23	33	19 2	33	40	32	18 19	31
29	21 7	50	46	50	20 25	50	20 3	49	41	49	19 18	48	56	47
30	49	46 7	21 27	47 7	21 5	48 7	42	49 6	20 20	50 6	56	51 5	19 33	52 3
31	22 30	25	22 8	25	45	25	21 21	24	58	23	20 34	22	20 10	20
32	23 11	43	48	43	22 25	43	22 0	42	21 36	41	21 11	40	46	38
33	52	47 2	23 28	48 2	23 4	49 2	39	50 1	22 14	51 0	48	58	21 22	56
34	24 33	22	24 8	22	43	21	23 18	20	52	19	22 25	52 17	58	53 15
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36	54	48 4	25 28	49 3	25 1	50 3	24 34	51 2	24 6	52 0	38	58	23 10	56
37	26 34	26	26 7	25	39	25	25 11	23	43	22	24 14	53 19	45	54 17
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41	29 11	50 2	40	51 1	28 9	52 0	38	58	27 7	55	35	52	26 2	48
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44	31 5	51 23	30 32	52 21	59	53 19	29 25	54 16	51	55 13	28 17	56 9	42	57 4
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b	a = 42°		a = 43°		a = 44°		a = 45°		a = 46°		a = 47°		a = 48°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
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46	32 19	52 21	45	53 19	31 10	54 16	34	55 13	59	56 9	29 23	57 4	46	59
47	55	52	32 20	49	45	46	31 8	42	30 32	38	55	33	29 18	58 27
48	33 31	53 23	55	54 20	32 19	55 17	42	56 13	31 5	57 8	30 27	58 2	49	56
49	34 7	55	33 30	52	53	49	32 15	44	37	39	59	33	30 20	59 26
50	42	54 29	34 4	55 25	33 26	56 21	48	57 16	32 9	58 10	31 30	59 4	50	56
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52	51	38	35 11	56 34	34 32	57 29	52	58 23	33 11	59 16	30	60 8	49	61 0
53	36 24	56 15	44	57 10	35 4	58 4	34 23	58	42	50	33 0	42	32 18	33
54	57	52	36 17	47	35	40	54	59 33	34 12	60 25	29	61 16	46	62 7
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57	33	50	50	43	37 6	60 35	36 22	61 26	38	62 15	53	63 4	34 8	53
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59	34	60 14	49	61 5	38 4	56	37 19	45	33	63 33	46	64 21	35 0	65 7
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74	36	59	40	73 32	45	74 4	49	74 35	54	75 6	58	75 35	40 2	76 4
75	53	73 58	57	74 29	44 1	75 0	43 5	75 29	42 9	58	41 12	76 26	16	53
76	46 9	74 58	45 12	75 27	16	56	19	76 24	23	76 51	26	77 17	29	77 43
77	24	75 58	27	76 26	30	76 53	33	77 19	36	77 45	39	78 9	41	78 33
78	38	77 0	41	77 26	43	77 51	46	78 15	48	78 39	51	79 2	53	79 24
79	51	78 2	53	78 26	55	78 49	57	79 12	43 0	79 34	42 2	55	41 3	80 15
80	47 3	79 5	46 5	79 27	45 6	79 48	44 8	80 9	10	80 29	12	80 48	13	81 7
81	13	80 9	15	80 29	16	80 48	18	81 7	20	81 25	21	81 42	22	59
82	23	81 13	24	81 31	26	81 48	27	82 5	28	82 21	29	82 36	30	82 52
83	32	82 18	32	82 33	34	82 48	34	83 3	35	83 17	36	83 31	37	83 45
84	39	83 23	40	83 36	41	83 49	41	84 2	42	84 14	42	84 26	43	84 38
85	46	84 28	46	84 39	47	84 50	47	85 1	47	85 11	48	85 21	48	85 31
86	51	85 34	51	85 43	51	85 52	52	86 0	52	86 9	52	86 17	52	86 24
87	55	86 40	55	86 47	55	86 54	55	87 0	55	87 6	56	87 12	56	87 18
88	58	87 47	58	87 51	58	87 56	58	88 0	58	88 4	58	88 8	58	88 12
89	59	88 53	59	88 56	59	88 58	59	89 0	59	89 2	43 0	89 4	42 0	89 6
90	48 0	90 0	47 0	90 0	46 0	90 0	45 0	90 0	44 0	90 0	0	90 0	0	90 0

b	a = 49°		a = 50°		a = 51°		a = 52°		a = 53°		a = 54°		a = 55°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	49 0	0 0	50 0	0 0	51 0	0 0	52 0	0 0	53 0	0 0	54 0	0 0	55 0
1	39	0	39	0	38	0	37	0	36	0	35	0	34	0
2	1 19	1	1 17	1	1 16	1	1 14	1	1 12	1	1 11	1	1 9	1
3	58	2	56	2	53	2	51	2	48	2	46	2	43	2
4	2 37	4	2 34	4	2 31	4	2 28	4	2 24	4	2 21	4	2 18	4
5	3 17	6	3 13	6	3 9	6	3 5	6	3 0	6	56	6	52	6
6	56	9	51	9	47	9	41	9	36	9	3 31	9	3 26	9
7	4 35	13	4 30	13	4 24	13	4 18	12	4 12	12	4 6	12	4 0	12
8	5 14	17	5 8	17	5 2	17	55	16	48	16	41	16	35	16
9	53	21	46	21	39	21	5 32	21	5 24	20	5 16	20	5 9	20
10	6 32	26	6 25	26	6 16	26	6 8	26	6 0	25	51	25	43	25
11	7 11	32	7 3	31	54	31	45	31	36	30	6 26	30	6 17	30
12	50	38	41	37	7 31	37	7 21	37	7 11	36	7 1	36	51	36
13	8 29	44	8 19	44	8 8	44	58	43	47	43	36	42	7 25	42
14	9 8	51	57	51	45	51	8 34	50	8 22	50	8 11	49	59	49
15	47	59	9 35	59	9 22	58	9 10	58	58	57	45	56	8 32	56
16	10 25	50 7	10 12	51 7	59	52 6	46	53 6	9 33	54 5	9 19	55 4	9 6	56 3
17	11 4	16	50	15	10 36	15	10 22	14	10 8	13	54	12	39	11
18	42	25	11 28	24	11 13	24	58	23	43	22	10 28	21	10 13	20
19	12 20	35	12 5	34	49	34	11 34	33	11 18	32	11 2	31	46	29
20	58	45	42	45	12 26	44	12 9	43	53	42	36	41	11 19	39
21	13 36	56	13 19	56	13 2	55	45	54	12 27	52	12 10	51	52	49
22	14 14	51 8	56	52 7	38	53 6	13 20	54 5	13 2	55 3	43	56 2	12 25	57 0
23	51	20	14 33	19	14 14	18	55	17	36	15	13 17	14	57	12
24	15 29	33	15 9	32	50	30	14 30	29	14 10	27	50	26	13 30	24
25	16 6	46	46	45	15 26	43	15 5	42	44	40	14 23	38	14 2	36
26	43	52 0	16 22	59	16 1	57	40	55	15 18	53	56	51	34	49
27	17 20	14	58	53 13	36	54 11	16 14	55 9	51	56 7	15 29	57 5	15 6	58 2
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29	18 33	45	18 10	44	46	42	17 22	39	58	37	33	34	16 9	31
30	19 9	53 2	45	54 0	18 20	58	56	55	17 31	52	17 5	49	40	46
31	45	19	19 20	17	55	55 14	18 29	56 11	18 3	57 8	37	58 5	17 11	59 2
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34	21 31	54 13	21 4	55 11	37	56 7	20 8	57 4	40	58 0	19 11	56	42	52
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36	41	53	22 12	50	43	46	21 13	42	43	38	20 13	33	42	28
37	23 15	55 14	46	56 10	22 16	57 7	45	58 2	21 14	58	43	52	20 12	47
38	49	35	23 19	32	48	28	22 17	23	45	59 18	21 13	60 12	41	61 7
39	24 23	57	52	54	23 20	49	48	44	22 15	39	43	33	21 10	27
40	57	56 20	24 24	57 16	52	58 11	23 19	59 6	45	60 0	22 12	54	38	48
41	25 30	44	56	39	24 23	34	50	29	23 15	22	41	61 16	22 6	62 9
42	26 3	57 8	25 28	58 3	54	58	24 20	52	45	45	23 10	38	34	31
43	35	33	26 0	28	25 25	59 22	50	60 15	24 14	61 8	38	62 1	23 2	53
44	27 7	59	31	53	55	47	25 19	40	43	32	24 6	25	29	63 16
45	38	58 25	27 2	59 19	26 25	60 12	48	61 5	25 11	57	34	49	56	40

b	a = 49°		a = 50°		a = 51°		a = 52°		a = 53°		a = 54°		a = 55°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	27 38	58 25	27 2	59 19	26 25	60 12	25 48	61 5	25 11	61 57	24 34	62 49	23 56	63 40
46	28 9	52	32	46	55	38	26 17	31	39	62 22	25 1	63 13	24 22	64 4
47	40	59 20	28 2	60 13	27 24	61 5	46	57	26 7	48	28	38	48	29
48	29 11	49	32	41	53	33	27 14	62 24	34	63 15	54	64 4	25 14	54
49	41	60 18	29 1	61 10	28 21	62 1	41	52	27 1	42	26 20	31	39	65 20
50	30 10	48	30	40	49	30	28 8	63 20	27	64 9	46	58	26 4	46
51	39	61 19	58	62 10	29 17	63 0	35	49	53	38	27 11	65 26	28	66 13
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53	36	62 23	53	63 13	30 10	64 1	27	49	44	36	28 0	66 23	27 16	67 9
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55	30	63 30	46	64 18	31 2	65 5	30 17	52	32	37	47	67 22	28 2	68 7
56	57	64 5	32 12	52	27	38	41	66 24	56	67 9	29 10	53	24	37
57	33 23	40	37	65 26	51	66 12	31 5	57	30 19	41	32	68 25	45	69 8
58	48	65 16	33 2	66 2	32 15	47	28	67 31	41	68 14	54	57	29 6	39
59	34 13	53	26	38	39	67 22	51	68 5	31 3	47	30 15	69 29	27	70 10
60	37	66 31	50	67 14	33 2	58	32 13	40	25	69 21	36	70 2	47	42
61	35 1	67 9	34 13	52	24	68 34	35	69 15	46	56	56	36	30 7	71 15
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66	49	70 32	58	71 9	35 6	46	34 13	72 22	21	58	28	73 32	36	74 6
67	37 9	71 14	36 17	51	24	72 26	31	73 1	38	73 36	45	74 9	52	42
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73	51	75 44	56	76 13	37 0	76 41	36 4	77 8	35 8	77 35	34 12	78 1	16	78 26
74	39 6	76 31	38 10	59	13	77 25	17	51	21	78 16	24	41	28	79 5
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79	40 5	80 35	39 7	54	38 9	81 13	11	81 31	13	49	14	82 7	16	82 23
80	15	81 25	16	81 42	18	82 0	19	82 16	21	82 33	22	49	24	83 4
81	23	82 15	24	82 31	26	47	27	83 2	28	83 17	29	83 31	31	45
82	31	83 0	32	83 20	33	83 34	34	48	35	84 1	36	84 13	37	84 26
83	38	57	38	84 10	39	84 22	40	84 34	41	45	41	56	42	85 7
84	44	84 48	44	59	45	85 10	45	85 20	46	85 30	46	85 39	47	49
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89	41 0	89 8	40 0	89 10	39 0	89 11	38 0	89 13	37 0	89 15	36 0	89 16	35 0	89 18
90	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0

b	a = 56°		a = 57°		a = 58°		a = 59°		a = 60°		a = 61°		a = 62°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	56 0	0 0	57 0	0 0	58 0	0 0	59 0	0 0	60 0	0 0	61 0	0 0	62 0
1	34	0	33	0	32	0	31	0	30	0	29	0	28	0
2	1 7	1	1 5	1	1 4	1	1 2	1	1 0	1	58	1	56	1
3	41	2	38	2	35	2	33	2	30	2	1 27	2	1 25	2
4	2 14	4	2 11	4	2 7	4	2 4	4	2 0	4	56	4	53	3
5	48	6	43	6	39	6	34	6	30	6	2 25	6	2 21	5
6	3 21	9	3 16	9	3 11	8	3 5	8	3 0	8	54	8	49	8
7	54	12	48	12	42	11	36	11	30	11	3 23	11	3 17	11
8	4 28	16	4 21	15	4 14	15	4 7	15	59	14	52	14	45	14
9	5 1	20	53	19	45	19	37	19	4 29	18	4 21	18	4 13	18
10	34	24	5 26	24	5 17	24	5 8	23	59	23	50	22	41	22
11	6 7	29	58	29	48	29	38	28	5 29	28	5 19	27	5 8	26
12	40	35	6 30	35	6 20	34	6 9	33	58	33	47	32	36	31
13	7 13	41	7 2	41	51	40	39	39	6 28	38	6 16	38	6 4	37
14	46	48	34	47	7 22	46	7 9	45	57	44	44	44	31	43
15	8 19	55	8 6	54	53	53	39	52	7 26	51	7 13	50	59	49
16	52	57 3	38	58 2	8 24	59 0	8 9	59	55	58	41	57	7 26	56
17	9 25	11	9 10	10	55	8	39	60 7	8 24	61 6	8 9	62 4	53	63 3
18	57	19	42	18	9 26	17	9 9	15	53	14	37	12	8 20	11
19	10 29	28	10 13	27	56	26	39	24	9 22	22	9 5	20	47	19
20	11 1	38	44	36	10 27	35	10 9	33	51	31	33	29	9 14	27
21	33	48	11 15	46	57	45	38	43	10 19	40	10 0	38	41	36
22	12 5	59	46	57	11 27	55	11 7	53	48	50	28	48	10 8	45
23	37	58 10	12 17	59 8	57	60 6	36	61 3	11 16	62 1	55	58	34	55
24	13 9	22	48	19	12 27	17	12 5	14	44	12	11 22	63 9	11 0	64 5
25	40	34	13 19	31	57	29	34	26	12 12	23	49	20	26	16
26	14 11	47	49	44	13 26	41	13 3	38	40	35	12 16	31	52	27
27	42	59 0	14 19	57	55	54	31	50	13 7	47	43	43	12 18	39
28	15 13	14	49	60 10	14 24	61 7	59	62 3	34	59	13 9	55	44	51
29	44	28	15 19	24	53	21	14 27	17	14 1	63 12	36	64 8	13 9	65 4
30	16 14	43	48	39	15 22	35	55	31	28	26	14 2	21	34	17
31	44	58	16 17	54	50	50	15 23	45	55	40	28	35	59	30
32	17 14	60 14	46	61 10	16 18	62 5	50	63 0	15 22	55	53	49	14 24	44
33	44	30	17 15	26	46	21	16 17	15	48	64 10	15 19	65 4	49	58
34	18 13	47	44	42	17 14	37	44	31	16 14	25	44	19	15 13	66 13
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36	19 11	23	40	62 17	18 9	63 11	37	64 5	17 6	58	34	51	16 1	44
37	40	41	19 8	35	36	29	18 3	22	31	65 15	58	66 7	25	67 0
38	20 8	62 0	36	54	19 3	47	29	40	56	32	17 22	24	48	16
39	36	20	20 3	63 13	29	64 6	55	58	18 21	50	46	42	17 11	33
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44	51	64 7	22 14	58	36	48	58	38	20 19	27	41	68 16	19 2	69 4
45	23 17	30	39	65 20	22 0	66 10	21 22	59	42	48	20 3	36	23	24

b	a = 56°		a = 57°		a = 58°		a = 59°		a = 60°		a = 61°		a = 62°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	23 17	64 30	22 39	65 20	22 0	66 10	21 22	66 59	20 42	67 48	20 3	68 36	19 23	69 24
46	43	54	23 4	43	24	32	45	67 21	21 5	68 9	25	56	44	44
47	24 8	65 18	28	66 7	48	55	22 8	43	27	31	46	69 17	20 5	70 4
48	33	43	52	31	23 11	67 18	30	68 6	49	53	21 7	39	25	25
49	58	66 8	24 16	55	34	42	52	29	22 10	69 15	28	70 1	45	46
50	25 22	34	39	67 20	57	68 7	23 14	53	31	38	48	23	21 5	71 8
51	46	67 0	25 2	46	24 19	32	36	69 17	52	70 2	22 8	46	24	30
52	26 9	27	25	68 12	41	57	57	42	23 12	26	28	71 9	43	52
53	32	54	47	39	25 2	69 23	24 17	70 7	32	50	47	33	22 1	72 15
54	54	68 22	26 9	69 6	23	50	37	33	52	71 15	23 6	57	19	39
55	27 16	51	30	34	44	70 17	57	59	24 11	41	24	72 22	37	73 2
56	37	69 20	51	70 2	26 4	44	25 17	71 26	29	72 7	42	47	54	26
57	58	50	27 11	31	23	71 12	36	53	47	33	24 0	73 12	23 11	51
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59	38	51	50	31	27 1	72 10	26 12	48	23	73 26	33	74 4	44	41
60	58	71 22	28 9	72 1	19	39	29	73 17	40	54	49	30	59	75 7
61	29 17	54	27	32	37	73 9	46	46	56	74 22	25 5	57	24 14	33
62	35	72 26	45	73 3	54	39	27 3	74 15	26 12	50	21	75 25	29	59
63	53	59	29 2	35	28 11	74 10	19	45	27	75 19	36	53	44	76 26
64	30 10	73 32	19	74 7	27	41	35	75 15	42	48	50	76 21	58	53
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66	43	39	50	75 12	57	44	28 4	76 16	27 11	47	17	77 18	24	48
67	59	75 14	30 5	46	29 12	76 17	18	47	24	77 17	30	47	36	78 16
68	31 14	49	20	76 20	26	50	31	77 19	37	48	43	78 16	48	44
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70	42	77 1	47	77 29	52	56	57	78 23	28 2	50	27 6	79 16	11	42
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72	32 8	78 14	12	39	16	79 4	20	79 29	24	53	27	80 17	31	40
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74	31	79 28	34	51	37	80 14	40	36	44	57	46	81 19	50	40
75	42	80 6	44	80 27	47	49	50	81 10	53	81 30	55	50	58	82 10
76	52	44	54	81 4	56	81 24	59	44	29 1	82 3	28 3	82 22	27 6	40
77	33 1	81 22	32 3	41	31 5	82 0	30 7	82 18	9	36	11	54	13	83 11
78	10	82 1	11	82 19	13	36	15	53	17	83 9	18	83 26	20	41
79	18	40	19	56	21	83 12	22	83 28	24	43	25	58	26	84 12
80	25	83 19	26	83 34	28	48	29	84 3	30	84 16	31	84 30	32	43
81	32	59	32	84 12	34	84 25	35	38	36	50	37	85 3	37	85 15
82	38	84 38	38	50	39	85 2	40	85 13	41	85 24	42	35	42	46
83	43	85 18	43	85 28	44	39	45	49	45	58	46	86 8	46	86 18
84	47	58	48	86 7	48	86 16	49	86 24	49	86 33	50	41	50	49
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86	54	87 18	55	87 24	55	87 30	55	36	55	42	55	47	56	52
87	57	59	57	88 3	57	88 8	57	88 12	57	88 16	57	88 20	58	88 24
88	59	88 39	59	42	59	45	59	48	59	51	59	53	59	56
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b	a = 63°		a = 64°		a = 65°		a = 66°		a = 67°		a = 68°		a = 69°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	63 0	0 0	64 0	0 0	65 0	0 0	66 0	0 0	67 0	0 0	68 0	0 0	69 0
1	27	0	26	0	25	0	24	0	23	0	22	0	22	0
2	54	1	53	1	51	1	49	1	47	1	45	1	43	1
3	1 22	2	1 19	2	1 16	2	1 13	2	1 10	2	1 7	2	1 5	2
4	49	3	45	3	41	3	38	3	34	3	30	3	26	3
5	2 16	5	2 11	5	2 7	5	2 2	5	57	5	52	5	47	4
6	43	7	38	7	32	7	26	7	2 20	7	2 15	7	2 9	6
7	3 10	10	3 4	10	57	10	50	9	44	9	37	9	30	8
8	37	13	30	13	3 22	13	3 15	12	3 7	12	59	12	52	11
9	4 4	17	56	17	47	16	39	16	30	15	3 22	15	3 13	14
10	31	21	4 22	21	4 12	20	4 3	20	53	19	44	18	34	17
11	58	26	48	25	37	24	27	24	4 16	23	4 6	22	55	21
12	5 25	31	5 14	30	5 2	29	51	28	39	27	28	26	4 16	25
13	52	36	40	35	27	34	5 15	33	5 2	32	50	31	37	29
14	6 18	42	6 5	40	52	39	39	38	25	37	5 12	36	58	34
15	45	48	31	46	6 17	45	6 3	44	48	42	34	41	5 19	39
16	7 11	54	56	53	41	51	26	50	6 11	48	56	47	40	45
17	38	64 1	7 22	65 0	7 6	58	50	56	34	54	6 17	53	6 1	51
18	8 4	9	47	7	30	66 5	7 13	67 3	56	68 1	39	59	22	57
19	30	17	8 12	15	54	12	37	10	7 19	8	7 0	69 6	42	70 3
20	56	25	37	23	8 18	20	8 0	18	41	15	22	13	7 3	10
21	9 22	34	9 2	31	42	28	23	26	8 3	23	43	20	23	17
22	48	43	27	40	9 6	37	46	34	25	31	8 4	28	43	24
23	10 13	52	52	49	30	46	9 9	43	47	39	25	36	8 3	32
24	39	65 2	10 16	59	54	56	31	52	9 9	48	46	44	23	40
25	11 4	13	41	66 9	10 17	67 6	54	68 2	30	57	9 7	53	43	49
26	29	24	11 5	20	41	16	10 16	12	52	69 7	27	70 2	9 2	58
27	54	35	29	31	11 4	26	38	22	10 13	17	48	12	22	71 7
28	12 19	47	53	42	27	37	11 0	32	34	27	10 8	22	41	17
29	43	59	12 16	54	50	49	22	43	55	38	28	32	10 0	27
30	13 7	66 11	40	67 6	12 12	68 1	44	55	11 16	49	48	43	19	37
31	31	24	13 3	19	34	13	12 6	69 7	37	70 0	11 8	54	38	47
32	55	38	26	32	56	25	27	19	57	12	27	71 5	57	58
33	14 19	52	49	45	13 18	38	48	31	12 17	24	46	17	11 15	72 9
34	43	67 6	14 12	59	40	52	13 9	44	37	37	12 5	29	33	21
35	15 6	21	34	68 13	14 2	69 6	30	58	57	50	24	41	51	33
36	29	36	56	28	23	20	50	70 12	13 17	71 3	43	54	12 9	45
37	52	51	15 18	43	44	34	14 10	26	36	16	13 2	72 7	27	57
38	16 14	68 7	40	59	15 5	49	30	40	55	30	20	20	45	73 10
39	36	24	16 1	69 15	26	70 5	50	55	14 14	44	38	34	13 2	23
40	58	41	22	31	46	21	15 9	71 10	33	59	56	48	19	37
41	17 20	58	43	48	16 6	37	28	26	51	72 14	14 14	73 2	36	51
42	41	69 16	17 4	70 5	26	53	47	42	15 9	29	31	17	53	74 5
43	18 2	34	24	22	45	71 10	16 6	58	27	45	48	32	14 9	19
44	23	52	44	40	17 4	27	25	72 14	45	73 1	15 5	48	25	34
45	44	70 11	18 4	58	23	45	43	31	16 2	18	22	74 3	41	49

b	a = 63°		a = 64°		a = 65°		a = 66°		a = 67°		a = 68°		a = 69°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	18 44	70 11	18 4	70 58	17 23	71 45	16 43	72 31	16 2	73 18	15 22	74 3	14 41	74 49
46	19 4	30	23	71 17	42	72 3	17 1	49	19	34	38	19	56	75 4
47	24	50	42	36	18 0	21	18	73 7	36	51	54	36	15 11	20
48	43	71 10	19 1	55	18	40	35	25	53	74 8	16 10	52	26	36
49	20 2	31	19	72 15	36	59	52	43	17 9	26	26	75 9	41	52
50	21	52	37	36	53	73 19	18 9	74 2	25	44	41	26	56	76 8
51	40	72 13	55	56	19 10	39	25	21	41	75 3	56	44	16 10	25
52	58	35	20 12	73 17	27	59	41	40	56	21	17 10	76 2	24	42
53	21 16	57	29	38	43	74 19	57	75 0	18 11	40	24	20	38	59
54	33	73 20	46	74 0	59	40	19 13	20	26	59	38	38	51	77 17
55	50	43	21 3	22	20 15	75 1	28	40	40	76 19	52	57	17 4	35
56	22 7	74 6	19	45	30	23	43	76 1	54	39	18 6	77 16	17	53
57	23	30	34	75 7	45	45	57	22	19 8	59	19	35	29	78 11
58	39	54	49	30	21 0	76 7	20 11	43	21	77 19	32	55	41	30
59	54	75 18	22 4	54	14	30	24	77 5	34	40	44	78 15	53	49
60	23 9	42	19	76 18	28	53	37	27	47	78 1	56	35	18 5	79 8
61	24	76 7	33	42	42	77 16	50	49	59	22	19 8	55	16	27
62	38	33	46	77 6	55	39	21 3	78 11	20 11	44	19	79 16	27	47
63	52	59	59	31	22 7	78 3	15	34	23	79 6	30	37	37	80 7
64	24 5	77 25	23 12	56	19	27	27	57	34	28	41	58	47	27
65	18	51	24	78 21	31	51	38	79 20	45	50	51	80 19	57	47
66	30	78 18	36	47	43	79 16	49	44	55	80 12	20 1	40	19 7	81 8
67	42	45	48	79 13	54	41	59	80 8	21 5	35	10	81 2	16	28
68	54	79 12	59	39	23 4	80 6	22 9	32	15	58	19	24	25	49
69	25 5	39	24 10	80 5	14	31	19	56	24	81 21	28	46	33	82 10
70	15	80 7	20	32	24	56	28	81 20	33	44	37	82 8	41	31
71	25	35	29	59	33	81 22	37	45	41	82 8	45	30	49	53
72	35	81 3	38	81 26	42	48	45	82 10	49	32	52	53	56	83 14
73	44	32	47	53	50	82 14	53	35	57	56	59	83 16	20 3	36
74	53	82 0	55	82 20	58	40	23 1	83 0	22 4	83 20	21 6	39	9	58
75	26 1	29	25 3	48	24 6	83 7	8	26	11	44	13	84 2	15	84 20
76	8	58	10	83 16	13	34	15	51	17	84 8	19	25	21	42
77	15	83 28	17	44	19	84 1	21	84 17	23	33	25	48	26	85 4
78	22	57	23	84 13	25	28	27	43	28	57	30	85 12	31	26
79	28	84 27	29	41	31	55	32	85 9	33	85 22	35	36	36	49
80	33	57	34	85 9	36	85 22	37	35	38	47	39	59	40	86 11
81	38	85 27	39	38	40	50	41	86 1	42	86 12	43	86 23	44	34
82	43	57	43	86 7	44	86 17	45	27	46	37	47	47	47	57
83	47	86 27	47	36	48	45	49	54	49	87 2	50	87 11	50	87 19
84	50	57	51	87 5	51	87 12	52	87 20	52	28	53	35	53	42
85	53	87 27	54	34	54	40	54	47	54	53	55	59	55	88 5
86	56	58	56	88 3	56	88 8	56	88 13	56	88 18	57	88 23	57	28
87	58	88 28	58	32	58	36	58	40	58	44	58	47	58	51
88	59	59	59	89 1	59	89 4	59	89 7	59	89 9	59	89 12	59	89 14
89	27 0	89 29	26 0	31	25 0	32	24 0	33	23 0	34	22 0	36	21 0	37
90	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0

b	a = 70°		a = 71°		a = 72°		a = 73°		a = 74°		a = 75°		a = 76°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	70 0	0 0	71 0	0 0	72 0	0 0	73 0	0 0	74 0	0 0	75 0	0 0	76 0
1	21	0	20	0	19	0	18	0	17	0	16	0	15	0
2	41	1	39	1	37	1	35	1	33	1	31	1	29	0
3	1 2	2	59	2	56	1	53	1	50	1	47	1	44	1
4	22	3	1 18	3	1 14	2	1 10	2	1 6	2	1 2	2	58	2
5	43	4	38	4	33	4	28	4	23	3	18	3	1 13	3
6	2 3	6	57	6	51	6	45	5	39	5	33	5	27	4
7	23	8	2 17	8	2 9	8	2 3	7	56	7	49	6	41	6
8	44	11	36	10	28	10	20	9	2 12	9	2 4	8	56	8
9	3 4	14	55	13	46	13	37	12	28	11	19	10	2 10	10
10	24	17	3 15	16	3 5	16	55	15	45	14	35	13	25	12
11	45	20	34	19	23	19	3 12	18	3 1	17	50	16	39	15
12	4 5	24	53	23	41	22	29	21	17	20	3 5	19	53	18
13	25	28	4 12	27	59	26	46	25	33	23	20	22	3 7	21
14	45	33	31	31	4 17	30	4 3	29	49	27	35	25	21	24
15	5 5	38	50	36	35	34	20	33	4 5	31	50	29	35	27
16	25	43	5 9	41	53	39	37	37	21	35	4 5	33	49	31
17	44	49	28	46	5 11	44	54	42	37	40	20	38	4 3	35
18	6 4	55	46	52	29	49	5 11	47	53	45	35	42	17	40
19	24	71 1	6 5	58	46	55	28	52	5 9	50	50	47	31	44
20	43	7	24	72 4	6 4	73 1	44	58	25	55	5 5	52	45	49
21	7 3	14	42	11	21	7	6 1	74 4	40	75 1	19	57	59	54
22	22	21	7 0	18	39	14	17	10	56	7	34	76 3	5 12	59
23	41	29	18	25	56	21	34	17	6 11	13	48	9	26	77 4
24	8 0	37	36	32	7 13	28	50	24	26	19	6 3	15	39	10
25	19	45	54	40	30	35	7 6	31	41	26	17	21	52	16
26	38	53	8 12	48	47	43	22	38	56	33	31	27	6 5	22
27	56	72 2	30	56	8 4	51	38	46	7 11	40	45	34	18	28
28	9 15	11	48	73 5	21	59	54	54	26	48	59	41	31	35
29	33	20	9 5	14	37	74 8	8 9	75 2	41	55	7 13	48	44	42
30	51	30	22	24	53	17	25	10	55	76 3	26	56	57	49
31	10 9	40	39	34	9 9	26	40	19	8 10	11	40	77 4	7 10	56
32	27	51	56	44	25	36	55	28	24	20	53	12	22	78 4
33	44	73 2	10 13	54	41	46	9 10	37	38	29	8 6	20	34	11
34	11 2	13	30	74 4	57	56	25	46	52	38	19	28	46	19
35	19	24	46	15	10 13	75 6	39	56	9 6	47	32	37	58	27
36	36	36	11 2	26	28	16	54	76 6	19	56	45	46	8 10	36
37	53	48	18	37	43	27	10 8	17	33	77 6	58	55	22	44
38	12 9	74 0	34	49	58	38	22	27	46	16	9 10	78 4	34	53
39	26	12	50	75 1	11 13	50	36	38	59	26	22	14	46	79 2
40	42	25	12 5	13	28	76 1	50	49	10 12	37	34	24	57	11
41	58	38	20	26	42	13	11 4	77 0	25	47	46	34	9 8	21
42	13 14	52	35	39	56	26	17	12	38	58	58	44	19	30
43	29	75 6	50	52	12 10	38	30	24	50	78 9	10 10	55	30	40
44	44	20	13 4	76 5	24	51	43	36	11 2	21	22	79 5	41	50
45	59	34	18	19	38	77 4	56	48	14	32	33	16	51	80 0

b	a = 70°		a = 71°		a = 72°		a = 73°		a = 74°		a = 75°		a = 76°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	13 59	75 34	13 18	76 19	12 38	77 4	11 56	77 48	11 14	78 32	10 33	79 16	9 51	80 0
46	14 14	49	32	33	51	17	12 9	78 1	26	44	44	27	10 1	10
47	29	76 4	46	47	13 4	30	21	13	38	56	55	39	11	21
48	43	19	14 0	77 1	17	44	33	26	49	79 8	11 6	50	21	32
49	57	34	13	16	29	58	45	39	12 0	21	16	80 2	31	43
50	15 11	50	26	31	41	78 12	57	53	11	33	26	14	41	54
51	25	77 6	39	46	53	26	13 8	79 7	22	46	36	26	50	81 5
52	38	22	52	78 2	14 5	41	19	21	33	59	46	38	59	16
53	51	39	15 4	18	17	56	30	35	43	80 13	56	50	11 8	28
54	16 4	55	16	34	29	79 11	41	49	53	26	12 5	81 3	17	40
55	16	78 12	28	50	40	26	52	80 3	13 3	40	14	16	26	52
56	28	30	40	79 6	51	42	14 2	18	13	54	23	29	34	82 4
57	40	47	51	23	15 1	58	12	33	22	81 8	32	42	42	16
58	52	79 5	16 2	40	11	80 14	22	48	31	22	41	55	50	28
59	17 3	23	12	57	21	30	31	81 3	40	36	49	82 9	58	41
60	14	41	22	80 14	31	46	40	18	49	50	57	22	12 6	54
61	24	80 0	32	31	41	81 3	49	34	57	82 5	13 5	36	13	83 7
62	34	18	42	49	50	20	58	50	14 5	20	13	50	20	20
63	44	37	52	81 7	59	37	15 6	82 6	13	35	20	83 4	27	33
64	54	56	17 1	25	16 8	54	14	22	21	50	27	18	34	46
65	18 3	81 15	10	43	16	82 11	22	38	28	83 5	34	32	40	59
66	12	35	18	82 2	24	28	30	55	35	21	41	47	46	84 12
67	21	54	26	20	32	46	37	83 11	42	36	47	84 1	52	26
68	29	82 14	34	39	39	83 4	44	28	49	52	53	16	58	40
69	37	34	42	58	46	22	51	45	55	84 8	59	31	13 3	54
70	45	54	49	83 17	53	40	57	84 2	15 1	24	14 5	46	8	85 8
71	52	83 15	56	36	59	58	16 3	19	7	40	10	85 1	13	22
72	59	35	18 2	56	17 5	84 16	9	36	12	56	15	16	18	36
73	19 6	56	8	84 15	11	34	14	53	17	85 12	20	31	23	50
74	12	84 16	14	35	17	53	19	85 11	22	29	25	47	27	86 4
75	18	37	20	54	22	85 12	24	28	27	45	29	86 2	31	18
76	23	58	25	85 14	27	30	29	46	31	86 2	33	17	35	33
77	28	85 19	30	34	31	49	33	86 4	35	19	37	33	38	47
78	33	40	34	54	35	86 8	37	22	39	35	40	49	41	87 2
79	37	86 2	38	86 14	39	27	41	40	42	52	43	87 4	44	17
80	41	23	42	35	43	46	44	58	45	87 9	46	20	47	31
81	45	44	45	55	46	87 5	47	87 16	48	26	49	36	50	46
82	48	87 6	48	87 15	49	25	50	34	51	43	51	52	52	88 1
83	51	28	51	36	52	44	52	52	53	88 0	53	88 8	54	15
84	53	49	53	56	54	88 3	54	88 10	55	17	55	24	56	30
85	55	88 11	55	88 17	56	23	56	28	56	34	57	40	57	45
86	57	33	57	37	57	42	57	47	57	51	58	56	58	89 0
87	58	55	58	58	58	89 1	58	89 5	58	89 8	59	89 12	59	15
88	59	89 16	59	89 19	59	21	59	23	59	26	15 0	28	14 0	30
89	20 0	38	19 0	39	18 0	40	17 0	42	16 0	43	0	44	0	45
90	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0

b	a = 77°		a = 78°		a = 79°		a = 80°		a = 81°		a = 82°		a = 83 °	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	77 0	0 0	78 0	0 0	79 0	0 0	80 0	0 0	81 0	0 0	82 0	0 0	83 0
1	14	0	12	0	11	0	10	0	9	0	8	0	7	0
2	27	0	25	0	23	0	21	0	19	0	17	0	15	0
3	41	1	37	1	34	1	31	1	28	1	25	1	22	1
4	54	2	50	2	46	2	42	1	38	1	33	1	29	1
5	1 7	3	1 2	3	57	3	52	2	47	2	42	2	37	2
6	21	4	15	4	1 9	4	1 2	3	56	3	50	3	44	2
7	34	6	27	5	20	5	13	4	1 6	4	58	4	51	3
8	48	7	39	7	31	6	23	6	15	5	1 7	5	58	4
9	2 1	9	52	9	43	8	33	7	24	6	15	6	1 6	5
10	14	11	2 4	11	54	10	44	9	33	8	23	7	13	6
11	28	14	17	13	2 5	12	54	11	43	10	31	9	20	8
12	41	16	29	15	16	14	2 4	13	52	12	40	10	27	9
13	54	19	41	18	28	16	14	15	2 1	14	48	12	34	11
14	3 7	22	53	21	39	19	24	17	10	16	56	14	41	12
15	20	26	3 5	24	50	22	34	20	19	18	2 4	16	48	14
16	33	29	17	27	3 1	25	44	23	28	20	12	18	55	16
17	46	33	29	30	12	28	54	26	37	23	20	21	2 2	18
18	59	37	41	34	23	31	3 4	29	46	26	28	23	9	20
19	4 12	41	53	38	34	35	14	32	55	29	36	26	16	23
20	25	45	4 5	42	45	39	24	35	3 4	32	44	29	23	25
21	37	50	17	46	55	43	34	39	13	35	52	32	30	28
22	50	55	28	51	4 6	47	44	43	22	39	59	35	37	30
23	5 3	78 0	40	56	17	51	53	47	30	42	3 7	38	44	33
24	15	5	51	79 1	27	56	4 3	51	39	46	15	41	50	36
25	27	11	5 3	6	38	80 1	13	55	47	50	22	44	57	39
26	39	17	14	11	48	6	22	81 0	56	54	30	48	3 4	42
27	51	23	25	16	58	11	31	4	4 5	58	37	52	10	45
28	6 3	29	36	22	5 8	16	41	9	13	82 2	45	56	17	49
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30	27	41	58	34	28	27	59	19	29	11	59	4	30	56
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32	51	55	20	47	48	39	17	30	45	21	14	12	42	3
33	7 2	79 3	30	54	58	45	26	35	53	26	21	17	48	7
34	14	10	41	80 1	6 8	51	34	41	5 1	31	28	21	54	11
35	25	17	51	8	17	57	43	47	9	36	35	26	4 0	15
36	36	25	7 1	15	27	81 4	52	53	17	42	42	31	6	20
37	47	33	11	22	36	11	6 0	59	24	47	48	36	12	24
38	58	41	21	29	45	18	8	82 5	32	53	55	41	18	28
39	8 8	50	31	37	54	25	16	12	39	59	5 2	46	24	33
40	19	58	41	45	7 3	32	24	18	46	83 5	8	51	30	38
41	29	80 7	51	53	12	39	32	25	53	11	14	57	35	42
42	39	16	8 0	81 1	20	47	40	32	6 0	17	21	84 2	41	47
43	49	25	9	10	29	55	48	39	7	23	27	8	46	52
44	59	34	18	18	37	82 2	56	46	14	30	33	14	52	57
45	9 9	43	27	27	45	10	7 3	54	21	37	39	20	57	85 2

b	a = 77° K	a = 77° Q	a = 78° K	a = 78° Q	a = 79° K	a = 79° Q	a = 80° K	a = 80° Q	a = 81° K	a = 81° Q	a = 82° K	a = 82° Q	a = 83° K	a = 83° Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	9 9	80 43	8 27	81 27	7 45	82 10	7 3	82 54	6 21	83 37	5 39	84 20	4 57	85 2
46	19	53	36	36	53	19	11	83 1	28	43	45	26	5 2	7
47	28	81 3	45	45	8 1	27	18	9	34	50	51	32	7	13
48	37	13	53	54	9	35	25	16	41	57	56	38	12	18
49	46	23	9 2	82 4	17	44	32	24	47	84 4	6 2	44	17	24
50	55	33	10	13	24	53	39	32	53	11	7	50	21	29
51	10 4	44	18	23	32	83 2	45	40	59	18	13	57	26	35
52	13	55	26	33	39	11	52	48	7 5	26	18	85 3	31	41
53	21	82 6	34	43	46	20	58	57	11	33	23	10	35	46
54	29	17	41	53	53	29	8 4	84 5	16	41	28	17	40	52
55	37	28	48	83 3	9 0	38	10	13	22	49	33	23	44	58
56	45	39	55	13	6	48	16	22	27	56	38	30	48	86 4
57	53	50	10 2	24	13	57	22	31	32	85 4	42	37	52	10
58	11 0	83 1	9	34	19	84 7	28	40	37	12	47	44	56	17
59	7	13	16	45	25	17	34	49	42	20	51	52	6 0	23
60	14	25	23	56	31	27	39	58	47	28	55	59	4	29
61	21	37	29	84 7	37	37	44	85 7	52	37	59	86 6	7	36
62	28	49	35	18	42	47	49	16	57	45	7 3	13	11	42
63	34	84 1	41	29	47	57	54	25	8 1	53	7	21	14	49
64	40	13	46	41	52	85 8	59	35	5	86 2	11	28	17	55
65	46	25	52	52	57	18	9 4	44	9	10	15	36	20	87 2
66	52	38	57	85 4	10 2	29	8	54	13	19	19	44	23	8
67	57	51	11 2	15	7	39	12	86 4	17	28	22	51	26	15
68	12 2	85 3	7	27	11	50	16	13	21	36	25	59	29	22
69	7	16	12	39	15	86 1	20	23	24	45	28	87 7	32	29
70	12	29	16	51	19	12	24	33	27	54	31	15	35	36
71	17	42	20	86 3	23	23	27	43	30	87 3	34	23	37	43
72	21	55	24	15	27	34	30	53	33	12	37	31	39	50
73	25	86 8	28	27	31	45	33	87 3	36	21	39	39	42	57
74	29	22	32	39	34	56	36	13	39	30	41	47	44	88 4
75	33	35	35	51	37	87 7	39	23	42	39	43	55	46	11
76	37	48	38	87 3	40	18	42	33	44	48	45	88 3	48	18
77	40	87 2	41	16	43	30	45	44	46	58	47	11	49	25
78	43	15	44	28	46	41	47	54	48	88 7	49	20	51	32
79	46	29	47	41	48	53	49	88 4	50	16	51	28	52	39
80	48	42	49	53	50	88 4	51	15	52	25	53	36	54	47
81	50	56	51	88 6	52	15	53	25	54	35	54	44	55	54
82	52	88 10	53	18	54	27	54	36	55	44	55	53	56	89 1
83	54	23	55	31	55	39	55	46	56	54	56	89 1	57	9
84	56	37	56	44	56	50	56	57	57	89 3	57	10	58	16
85	57	51	57	56	57	89 2	57	89 7	58	13	58	18	58	23
86	58	89 5	58	89 9	58	13	58	18	59	22	59	26	59	31
87	59	18	59	22	59	25	59	28	59	31	59	35	59	38
88	13 0	32	12 0	34	11 0	37	10 0	39	9 0	41	8 0	43	7 0	45
89	0	46	0	47	0	48	0	49	0	50	0	52	0	53
90	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0

b	a = 84°		a = 85°		a = 86°		a = 87°		a = 88°		a = 89°		a = 90°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	0 0	84 0	0 0	85 0	0 0	86 0	0 0	87 0	0 0	88 0	0 0	89 0	0 0	90 0
1	6	0	5	0	4	0	3	0	2	0	1	0	0	0
2	13	0	10	0	8	0	6	0	4	0	2	0	0	0
3	19	0	16	0	13	0	9	0	6	0	3	0	0	0
4	25	1	21	1	17	1	13	0	8	0	4	0	0	0
5	31	1	26	1	21	1	16	1	10	0	5	0	0	0
6	38	2	31	2	25	1	19	1	13	1	6	0	0	0
7	44	3	37	2	29	2	22	1	15	1	7	0	0	0
8	50	3	42	3	33	2	25	2	17	1	8	1	0	0
9	56	4	47	4	38	3	28	2	19	1	9	1	0	0
10	1 2	5	52	5	42	4	31	3	21	2	10	1	0	0
11	9	7	57	6	46	4	34	3	23	2	11	1	0	0
12	15	8	1 2	7	50	5	37	4	25	3	13	1	0	0
13	21	9	7	8	54	6	40	5	27	3	14	2	0	0
14	27	11	12	9	58	7	44	5	29	4	15	2	0	0
15	33	12	18	10	1 2	8	47	6	31	4	16	2	0	0
16	39	14	23	12	6	9	50	7	33	5	17	2	0	0
17	45	16	28	13	10	10	53	8	35	5	18	3	0	0
18	51	18	33	15	14	12	56	9	37	6	19	3	0	0
19	57	20	38	16	18	13	59	10	39	7	20	4	0	0
20	2 3	22	43	18	22	14	1 2	11	41	7	21	4	0	0
21	9	24	48	20	26	16	4	12	43	8	22	4	0	0
22	15	26	52	22	30	17	7	13	45	9	22	4	0	0
23	20	28	57	24	34	19	10	14	47	10	23	5	0	0
24	26	31	2 2	26	38	21	13	16	49	10	24	5	0	0
25	32	34	7	28	41	22	16	17	51	11	25	6	0	0
26	38	36	11	30	45	24	19	18	53	12	26	6	0	0
27	43	39	16	33	49	26	22	20	54	13	27	7	0	0
28	49	42	21	35	53	28	24	21	56	14	28	7	0	0
29	54	45	25	37	56	30	27	23	58	15	29	8	0	0
30	3 0	48	30	40	2 0	32	30	24	1 0	16	30	8	0	0
31	5	51	35	43	4	34	33	26	2	17	31	9	0	0
32	11	54	39	45	7	36	35	27	4	18	32	9	0	0
33	16	58	43	48	11	39	38	29	5	19	33	10	0	0
34	21	85 1	48	51	14	41	41	31	7	20	34	10	0	0
35	26	5	52	54	18	43	43	33	9	22	34	11	0	0
36	31	8	56	57	21	46	46	34	11	23	35	11	0	0
37	36	12	3 0	86 0	24	48	48	36	12	24	36	12	0	0
38	41	16	5	3	28	51	51	38	14	25	37	13	0	0
39	46	20	9	7	31	53	53	40	16	27	38	14	0	0
40	51	24	13	10	34	56	56	42	17	28	39	14	0	0
41	56	28	17	13	37	59	58	44	19	29	39	15	0	0
42	4 1	32	21	17	41	87 2	2 0	46	20	31	40	15	0	0
43	5	36	25	20	44	4	3	48	22	32	41	16	0	0
44	10	41	28	24	47	7	5	50	23	34	42	17	0	0
45	14	45	32	28	50	10	7	53	25	35	43	18	0	0

b	a = 84°		a = 85°		a = 86°		a = 87°		a = 88°		a = 89°		a = 90°	
	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q	K	Q
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
45	4 14	85 45	3 32	86 28	2 50	87 10	2 7	87 53	1 25	88 35	0 43	89 18	0 0	90 0
46	19	49	36	31	53	13	9	55	26	37	43	18	0	0
47	23	54	39	35	55	16	12	57	28	38	44	19	0	0
48	27	59	43	39	58	19	14	59	29	40	45	20	0	0
49	31	86 3	46	43	3 1	22	16	88 2	31	41	45	21	0	0
50	35	8	50	47	4	26	18	4	32	43	46	21	0	0
51	39	13	53	51	7	29	20	7	33	44	46	22	0	0
52	43	18	56	55	9	32	22	9	35	46	47	23	0	0
53	47	23	59	59	12	35	24	12	36	48	48	24	0	0
54	51	28	4 2	87 3	14	39	26	14	37	49	49	25	0	0
55	55	33	5	8	17	42	27	17	38	51	49	26	0	0
56	58	38	8	12	19	46	29	19	39	53	50	26	0	0
57	5 2	43	11	16	21	49	31	22	41	55	50	27	0	0
58	5	49	14	21	24	53	33	25	42	56	51	28	0	0
59	8	54	17	25	26	56	34	27	43	58	51	29	0	0
60	11	87 0	20	30	28	88 0	36	30	44	89 0	52	30	0	0
61	14	5	22	34	30	3	37	33	45	2	52	31	0	0
62	17	11	25	39	32	7	39	35	46	4	53	32	0	0
63	20	16	27	44	34	11	40	38	47	5	53	33	0	0
64	23	22	30	48	36	15	42	41	48	7	54	34	0	0
65	26	27	32	53	38	18	43	44	49	9	54	35	0	0
66	29	33	34	58	39	22	44	47	50	11	55	36	0	0
67	31	39	36	88 3	41	26	46	50	50	13	55	37	0	0
68	34	45	38	7	42	30	47	53	51	15	56	38	0	0
69	36	51	40	12	44	34	48	55	52	17	56	38	0	0
70	38	56	42	17	46	38	49	58	53	19	56	39	0	0
71	40	88 2	44	22	47	42	50	89 1	53	21	56	40	0	0
72	42	8	45	27	48	46	51	4	54	23	57	41	0	0
73	44	14	47	32	50	50	52	7	55	25	57	42	0	0
74	46	20	49	37	51	54	53	10	55	27	58	43	0	0
75	48	27	50	42	52	58	54	13	56	29	58	44	0	0
76	49	33	51	47	53	89 2	55	16	56	31	58	45	0	0
77	51	39	52	52	54	6	55	19	57	33	58	46	0	0
78	52	45	53	57	55	10	56	23	57	35	59	47	0	0
79	53	51	54	89 3	56	14	57	26	58	37	59	49	0	0
80	54	57	55	8	56	18	57	29	58	39	59	50	0	0
81	55	89 3	56	13	57	22	58	32	59	41	59	51	0	0
82	56	10	57	18	58	27	58	35	59	43	59	52	0	0
83	57	16	58	23	58	31	59	38	59	45	1 0	53	0	0
84	58	22	58	29	59	35	59	41	59	47	0	54	0	0
85	59	29	59	34	59	39	59	44	2 0	50	0	55	0	0
86	59	35	59	39	59	43	3 0	47	0	52	0	56	0	0
87	6 0	41	5 0	44	4 0	47	0	51	0	54	0	57	0	0
88	0	47	0	50	0	52	0	54	0	56	0	58	0	0
89	0	54	0	55	0	56	0	57	0	58	0	59	0	0
90	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	90 0	0	0

Larger Bearing	Smaller Bearing				
	2°	4°	6°	8°	10°
34°	0.07	0.14	0.22	0.32	0.43
36	.06	.13	.21	.30	.40
38	.06	.12	.20	.28	.37
40	.06	.12	.19	.26	.35
42	.05	.11	.18	.25	.33
44	.05	.11	.17	.24	.31
46	.05	.10	.16	.23	.30
48	.05	.10	.16	.22	.28
50	.05	.10	.15	.21	.27
52	.05	.09	.15	.20	.26
54	.04	.09	.14	.19	.25
56	.04	.09	.14	.19	.24
58	.04	.09	.13	.18	.23
60	.04	.08	.13	.18	.23
62	.04	.08	.13	.17	.22
64	.04	.08	.12	.17	.21
66	.04	.08	.12	.16	.21
68	.04	.08	.12	.16	.20
70	.04	.08	.12	.16	.20
72	.04	.08	.11	.15	.20
74	.04	.07	.11	.15	.19
76	.04	.07	.11	.15	.19
78	.04	.07	.11	.15	.19
80	.04	.07	.11	.15	.18
82	.04	.07	.11	.14	.18
84	.04	.07	.11	.14	.18
86	.04	.07	.11	.14	.18
88	.04	.07	.11	.14	.18
90	.03	.07	.11	.14	.18
92	.03	.07	.10	.14	.18
94	.03	.07	.10	.14	.17
96	.03	.07	.10	.14	.17
98	.04	.07	.10	.14	.17
100	.04	.07	.11	.14	.17
102	.04	.07	.11	.14	.17
104	.04	.07	.11	.14	.17
106	.04	.07	.11	.14	.17
108	.04	.07	.11	.14	.18
110	.04	.07	.11	.14	.18
112	.04	.07	.11	.14	.18
114	.04	.07	.11	.15	.18
116	.04	.07	.11	.15	.18
118	.04	.08	.11	.15	.18
120	.04	.08	.11	.15	.18
122	.04	.08	.12	.15	.19
124	.04	.08	.12	.16	.19
126	.04	.08	.12	.16	.19
128	.04	.08	.12	.16	.20
130	.04	.09	.13	.17	.20
132	.05	.09	.13	.17	.20
134	.05	.09	.13	.17	.21
136	.05	.09	.14	.18	.21
138	.05	.10	.14	.18	.22
140	.05	.10	.15	.19	.23
142	.05	.10	.15	.19	.23
144	.06	.11	.16	.20	.24
146	.06	.12	.16	.21	.25
148	.06	.12	.17	.22	.26
150	.07	.12	.18	.23	.27
152	.07	.13	.19	.24	.28
154	.07	.14	.20	.25	.30
156	.08	.15	.21	.26	.31
158	.09	.16	.22	.28	.33
160	.09	.17	.24	.30	.35

Larger Bearing	Smaller Bearing				
	12°	14°	16°	18°	20°
42°	0.42	0.52	0.63	0.76	0.91
44	.39	.48	.59	.70	.84
46	.37	.46	.55	.66	.78
48	.35	.43	.52	.62	.73
50	.34	.41	.49	.58	.68
52	.32	.39	.47	.55	.65
54	.31	.38	.45	.52	.61
56	.30	.36	.43	.50	.58
58	.29	.35	.41	.48	.56
60	.28	.34	.40	.46	.53
62	.27	.33	.38	.44	.51
64	.26	.32	.37	.43	.49
66	.26	.31	.36	.42	.48
68	.25	.30	.35	.40	.46
70	.24	.29	.34	.39	.45
72	.24	.28	.33	.38	.43
74	.23	.28	.32	.37	.42
76	.23	.27	.32	.36	.41
78	.23	.27	.31	.36	.40
80	.22	.26	.31	.35	.39
82	.22	.26	.30	.34	.39
84	.22	.26	.30	.34	.38
86	.22	.25	.29	.33	.37
88	.21	.25	.29	.33	.37
90	.21	.25	.29	.32	.36
92	.21	.25	.28	.32	.36
94	.21	.25	.28	.32	.36
96	.21	.24	.28	.32	.35
98	.21	.24	.28	.31	.35
100	.21	.24	.28	.31	.35
102	.21	.24	.28	.31	.35
104	.21	.24	.28	.31	.34
106	.21	.24	.28	.31	.34
108	.21	.24	.28	.31	.34
110	.21	.24	.28	.31	.34
112	.21	.24	.28	.31	.34
114	.21	.24	.28	.31	.34
116	.21	.25	.28	.31	.34
118	.22	.25	.28	.31	.35
120	.22	.25	.28	.32	.35
122	.22	.25	.29	.32	.35
124	.22	.26	.29	.32	.35
126	.23	.26	.29	.32	.36
128	.23	.26	.30	.33	.36
130	.23	.27	.30	.33	.36
132	.24	.27	.31	.34	.37
134	.24	.28	.31	.34	.37
136	.25	.28	.32	.35	.38
138	.26	.29	.32	.36	.39
140	.26	.30	.33	.36	.39
142	.27	.31	.34	.37	.40
144	.28	.32	.35	.38	.41
146	.29	.33	.36	.39	.42
148	.30	.34	.37	.40	.43
150	.31	.35	.38	.42	.45
152	.32	.36	.40	.43	.46
154	.34	.38	.41	.44	.48
156	.35	.39	.43	.46	.49
158	.37	.41	.45	.48	.51
160	.39	.43	.47	.50	.53
162	.41	.46	.49	.52	.56
164	.44	.48	.52	.55	.58
166	.47	.52	.55	.58	.61
168	.50	.55	.59	.62	.65

Larger Bearing	Smaller Bearing				
	22°	24°	26°	28°	30°
54°	0.71	0.81	0.93	1.07	1.23
56	.67	.77	.88	1.00	1.14
58	.64	.73	.83	0.94	1.07
60	.61	.69	.78	.89	1.00
62	.58	.66	.75	.84	0.94
64	.56	.63	.71	.80	.89
66	.54	.61	.68	.76	.85
68	.52	.59	.66	.73	.81
70	.50	.57	.63	.70	.78
72	.49	.55	.61	.68	.75
74	.48	.53	.59	.65	.72
76	.46	.52	.57	.63	.70
78	.45	.50	.56	.61	.67
80	.44	.49	.54	.60	.65
82	.43	.48	.53	.58	.63
84	.42	.47	.52	.57	.62
86	.42	.46	.51	.55	.60
88	.41	.45	.50	.54	.59
90	.40	.45	.49	.53	.58
92	.40	.44	.48	.52	.57
94	.39	.43	.47	.51	.56
96	.39	.43	.47	.51	.55
98	.39	.42	.46	.50	.54
100	.38	.42	.46	.49	.53
102	.38	.42	.45	.49	.53
104	.38	.41	.45	.48	.52
106	.38	.41	.45	.48	.52
108	.38	.41	.44	.48	.51
110	.37	.41	.44	.47	.51
112	.37	.41	.44	.47	.50
114	.37	.41	.44	.47	.50
116	.38	.41	.44	.47	.50
118	.38	.41	.44	.47	.50
120	.38	.41	.44	.47	.50
122	.38	.41	.44	.47	.50
124	.38	.41	.44	.47	.50
126	.39	.42	.45	.47	.50
128	.39	.42	.45	.48	.50
130	.39	.42	.45	.48	.51
132	.40	.43	.46	.48	.51
134	.40	.43	.46	.49	.52
136	.41	.44	.47	.49	.52
138	.42	.45	.47	.50	.53
140	.42	.45	.48	.51	.53
142	.43	.46	.49	.51	.54
144	.44	.47	.50	.52	.55
146	.45	.48	.51	.53	.56
148	.46	.49	.52	.54	.57
150	.48	.50	.53	.55	.58
152	.49	.52	.54	.57	.59
154	.50	.53	.56	.58	.60
156	.52	.55	.57	.60	.62
158	.54	.57	.59	.61	.63
160	.56	.59	.61	.63	.65
162	.58	.61	.63	.65	.67
164	.61	.63	.66	.68	.70
166	.64	.66	.68	.70	.72
168	.67	.69	.71	.73	.75
170	.71	.73	.75	.76	.78
172	.75	.77	.78	.80	.81
174	.80	.81	.83	.84	.85
176	.85	.87	.88	.89	.89
178	.92	.93	.93	.94	.94

Larger Bearing	Smaller Bearing				
	32°	34°	36°	38°	40°
62°	1.06	1.19	1.34	1.51	1.72
64	1.00	1.12	1.25	1.40	1.58
66	0.95	1.06	1.18	1.31	1.47
68	.90	1.00	1.11	1.23	1.37
70	.86	0.95	1.05	1.16	1.29
72	.82	.91	1.00	1.10	1.21
74	.79	.87	0.95	1.05	1.15
76	.76	.84	.91	1.00	1.09
78	.74	.80	.88	0.96	1.04
80	.71	.78	.85	.92	1.00
82	.69	.75	.82	.89	0.96
84	.67	.73	.79	.86	.93
86	.66	.71	.77	.83	.89
88	.64	.69	.75	.80	.86
90	.62	.67	.73	.78	.84
92	.61	.66	.71	.76	.82
94	.60	.65	.69	.74	.79
96	.59	.63	.68	.73	.78
98	.58	.62	.67	.71	.76
100	.57	.61	.65	.70	.74
102	.56	.60	.64	.68	.73
104	.56	.60	.63	.67	.72
106	.55	.59	.63	.66	.70
108	.55	.58	.62	.66	.69
110	.54	.58	.61	.65	.68
112	.54	.57	.61	.64	.68
114	.54	.57	.60	.63	.67
116	.53	.56	.60	.63	.66
118	.53	.56	.59	.63	.66
120	.53	.56	.59	.62	.65
122	.53	.56	.59	.62	.65
124	.53	.56	.59	.62	.65
126	.53	.56	.59	.62	.64
128	.53	.56	.59	.62	.64
130	.54	.56	.59	.62	.64
132	.54	.56	.59	.62	.64
134	.54	.57	.59	.62	.64
136	.55	.57	.60	.62	.65
138	.55	.58	.60	.63	.65
140	.56	.58	.61	.63	.65
142	.56	.59	.61	.63	.66
144	.57	.60	.62	.64	.66
146	.58	.60	.63	.65	.67
148	.59	.61	.63	.66	.68
150	.60	.62	.64	.66	.68
152	.61	.63	.65	.67	.69
154	.62	.65	.67	.68	.70
156	.64	.66	.68	.70	.72
158	.66	.67	.69	.71	.73
160	.67	.69	.71	.73	.74
162	.69	.71	.73	.74	.76
164	.71	.73	.75	.76	.78
166	.74	.75	.77	.78	.79
168	.76	.78	.79	.80	.82
170	.79	.80	.82	.83	.84
172	.82	.84	.85	.86	.86
174	.86	.87	.88	.89	.89
176	.90	.91	.91	.92	.93
178	.95	.95	.95	.96	.96

Larger Bearing	Smaller Bearing 42°	44°	46°	48°	50°
72°	1.34	1.48	1.64	1.83	2.04
74	1.26	1.39	1.53	1.70	1.88
76	1.20	1.31	1.44	1.58	1.75
78	1.14	1.24	1.36	1.49	1.63
80	1.09	1.18	1.28	1.40	1.53
82	1.04	1.13	1.22	1.33	1.45
84	1.00	1.08	1.17	1.26	1.37
86	0.96	1.04	1.12	1.21	1.30
88	.93	1.00	1.08	1.16	1.24
90	.90	0.97	1.04	1.11	1.19
92	.87	.93	1.00	1.07	1.14
94	.85	.91	0.97	1.03	1.10
96	.83	.88	.94	1.00	1.06
98	.81	.86	.91	0.97	1.03
100	.79	.84	.89	.94	1.00
102	.77	.82	.87	.92	0.97
104	.76	.80	.85	.90	.95
106	.74	.79	.83	.88	.92
108	.73	.77	.81	.86	.90
110	.72	.76	.80	.84	.88
112	.71	.75	.79	.83	.87
114	.70	.74	.78	.81	.85
116	.70	.73	.77	.80	.84
118	.69	.72	.76	.79	.83
120	.68	.72	.75	.78	.82
122	.68	.71	.74	.77	.81
124	.68	.71	.74	.77	.80
126	.67	.70	.73	.76	.79
128	.67	.70	.73	.75	.78
130	.67	.70	.72	.75	.78
132	.67	.70	.72	.75	.77
134	.67	.69	.72	.74	.77
136	.67	.70	.72	.74	.77
138	.67	.70	.72	.74	.77
140	.68	.70	.72	.74	.77
142	.68	.70	.72	.74	.77
144	.68	.71	.73	.75	.77
146	.69	.71	.73	.75	.77
148	.70	.72	.74	.76	.77
150	.70	.72	.74	.76	.78
152	.71	.73	.75	.77	.78
154	.72	.74	.76	.77	.79
156	.73	.75	.77	.78	.80
158	.74	.76	.78	.79	.81
160	.76	.77	.79	.80	.82
162	.77	.79	.80	.81	.83
164	.79	.80	.81	.83	.84
166	.81	.82	.83	.84	.85
168	.83	.84	.85	.86	.87
170	.85	.86	.87	.88	.88
172	.87	.88	.89	.90	.90
174	.90	.91	.91	.92	.92
176	.93	.93	.94	.94	.95
178	.96	.97	.97	.97	.97

Larger Bearing	Smaller Bearing 52°	54°	56°	58°	60°
82°	1.58	1.72	1.89	2.08	2.31
84	1.49	1.62	1.77	1.93	2.13
86	1.41	1.53	1.66	1.81	1.98
88	1.34	1.45	1.56	1.70	1.84
90	1.28	1.38	1.48	1.60	1.73
92	1.23	1.31	1.41	1.52	1.63
94	1.18	1.26	1.35	1.44	1.55
96	1.13	1.21	1.29	1.38	1.47
98	1.10	1.16	1.24	1.32	1.41
100	1.06	1.12	1.19	1.27	1.35
102	1.03	1.09	1.15	1.22	1.29
104	1.00	1.06	1.12	1.18	1.25
106	0.97	1.03	1.09	1.14	1.20
108	.95	1.00	1.05	1.11	1.17
110	.93	0.98	1.02	1.08	1.13
112	.91	.95	1.00	1.05	1.10
114	.89	.93	0.98	1.02	1.07
116	.88	.92	.96	1.00	1.04
118	.86	.90	.94	0.98	1.02
120	.85	.89	.91	.96	1.00
122	.84	.87	.90	.95	0.98
124	.83	.86	.90	.93	.96
126	.82	.85	.88	.91	.95
128	.81	.84	.87	.90	.93
130	.81	.83	.86	.89	.92
132	.80	.83	.85	.88	.91
134	.80	.82	.85	.87	.90
136	.80	.82	.84	.87	.89
138	.79	.81	.84	.86	.89
140	.79	.81	.83	.86	.88
142	.79	.81	.83	.85	.87
144	.79	.81	.83	.85	.87
146	.79	.81	.83	.85	.87
148	.79	.81	.83	.85	.87
150	.80	.81	.83	.85	.87
152	.80	.82	.83	.85	.87
154	.81	.82	.84	.85	.87
156	.81	.83	.84	.86	.87
158	.82	.83	.85	.86	.87
160	.83	.84	.85	.86	.88
162	.84	.85	.86	.87	.89
164	.85	.86	.87	.88	.89
166	.86	.87	.88	.89	.90
168	.88	.89	.90	.90	.91
170	.89	.90	.90	.91	.92
172	.91	.92	.91	.93	.93
174	.93	.93	.94	.95	.95
176	.95	.95	.96	.96	.96
178	.97	.98	.98	.98	.98

Larger Bearing	Smaller Bearing 62°	64°	66°	68°	70°
92°	1.77	1.91	2.08	2.28	2.51
94	1.67	1.80	1.95	2.12	2.31
96	1.58	1.70	1.83	1.97	2.14
98	1.50	1.61	1.72	1.85	2.00
100	1.43	1.53	1.63	1.75	1.88
102	1.37	1.46	1.55	1.66	1.77
104	1.32	1.40	1.48	1.58	1.68
106	1.27	1.34	1.42	1.51	1.60
108	1.23	1.29	1.37	1.44	1.53
110	1.19	1.25	1.32	1.39	1.46
112	1.15	1.21	1.27	1.33	1.40
114	1.12	1.17	1.23	1.29	1.35
116	1.09	1.14	1.19	1.25	1.31
118	1.07	1.11	1.16	1.21	1.26
120	1.04	1.08	1.13	1.18	1.23
122	1.02	1.06	1.10	1.15	1.19
124	1.00	1.04	1.08	1.12	1.16
126	0.98	1.02	1.05	1.09	1.13
128	.97	1.00	1.03	1.07	1.11
130	.95	0.98	1.02	1.05	1.09
132	.94	.97	1.00	1.03	1.06
134	.93	.96	0.99	1.01	1.04
136	.92	.95	.97	1.00	1.03
138	.91	.94	.96	0.99	1.01
140	.90	.93	.95	.97	1.00
142	.90	.92	.94	.96	0.99
144	.89	.91	.93	.96	.98
146	.89	.91	.93	.95	.97
148	.89	.90	.92	.94	.96
150	.88	.90	.92	.94	.95
152	.88	.90	.92	.93	.95
154	.88	.90	.91	.93	.94
156	.89	.90	.91	.93	.94
158	.89	.90	.91	.93	.94
160	.89	.90	.91	.93	.94
162	.90	.91	.92	.93	.94
164	.90	.91	.92	.93	.94
166	.91	.92	.93	.93	.94
168	.92	.93	.93	.94	.94
170	.93	.94	.94	.95	.95
172	.94	.95	.95	.96	.96
174	.95	.96	.96	.96	.97
176	.97	.97	.97	.97	.98
178	.98	.98	.99	.99	.99

Larger Bearing	Smaller Bearing 72°	74°	76°	78°	80°
102°	1.90	2.05	2.21	2.40	2.63
104	1.79	1.92	2.07	2.23	2.42
106	1.70	1.81	1.94	2.08	2.25
108	1.62	1.72	1.83	1.96	2.10
110	1.54	1.64	1.74	1.85	1.97
112	1.48	1.56	1.65	1.75	1.86
114	1.42	1.50	1.58	1.66	1.76
116	1.37	1.44	1.51	1.59	1.68
118	1.32	1.38	1.45	1.52	1.60
120	1.28	1.34	1.40	1.46	1.53
122	1.24	1.29	1.35	1.41	1.47
124	1.21	1.25	1.31	1.36	1.42
126	1.18	1.22	1.27	1.32	1.37
128	1.15	1.19	1.23	1.28	1.33
130	1.12	1.16	1.20	1.24	1.29
132	1.10	1.13	1.17	1.21	1.25
134	1.08	1.11	1.14	1.18	1.22
136	1.06	1.09	1.12	1.15	1.19
138	1.04	1.07	1.10	1.13	1.16
140	1.03	1.05	1.08	1.11	1.14
142	1.01	1.04	1.06	1.09	1.12
144	1.00	1.02	1.05	1.07	1.10
146	0.99	1.01	1.03	1.05	1.08
148	.98	1.00	1.02	1.04	1.06
150	.97	0.99	1.01	1.03	1.05
152	.97	.98	1.00	1.02	1.04
154	.96	.98	0.99	1.01	1.02
156	.96	.97	.99	1.00	1.01
158	.95	.97	.98	0.99	1.01
160	.95	.96	.98	.99	1.00
162	.95	.96	.98	.99	1.00
164	.95	.96	.98	.99	0.99
166	.96	.96	.98	.99	.99
168	.96	.96	.98	.99	.99
170	.97	.97	.98	.99	.99
172	.97	.97	.99	.99	.99
174	.98	.98	.99	.99	.99
176	.99	.98	.99	.99	.99
178	.99	.99	.99	.99	.99

Larger Bearing	Smaller Bearing 82°	84°	86°	88°	90°
112°	1.98	2.12	2.28	2.46	2.67
114	1.87	1.99	2.12	2.28	2.46
116	1.77	1.88	2.00	2.13	2.28
118	1.68	1.78	1.88	2.00	2.13
120	1.61	1.69	1.78	1.89	2.00
122	1.54	1.62	1.70	1.79	1.89
124	1.48	1.55	1.62	1.70	1.79
126	1.43	1.48	1.55	1.62	1.70
128	1.38	1.43	1.49	1.55	1.62
130	1.33	1.38	1.44	1.49	1.56
132	1.29	1.34	1.39	1.44	1.49
134	1.26	1.30	1.34	1.39	1.44
136	1.22	1.26	1.30	1.34	1.39
138	1.19	1.23	1.27	1.30	1.35
140	1.17	1.20	1.23	1.27	1.31
142	1.14	1.17	1.20	1.24	1.27
144	1.12	1.15	1.18	1.21	1.24
146	1.10	1.13	1.15	1.18	1.21
148	1.08	1.11	1.13	1.15	1.18
150	1.07	1.09	1.11	1.13	1.15
152	1.05	1.07	1.09	1.11	1.13
154	1.04	1.06	1.08	1.09	1.11
156	1.03	1.05	1.06	1.08	1.09
158	1.02	1.03	1.05	1.06	1.08
160	1.01	1.02	1.04	1.05	1.06
162	1.00	1.01	1.03	1.03	1.05
164	1.00	1.00	1.02	1.02	1.04
166	1.00	1.00	1.01	1.02	1.03
168	1.00	1.00	1.00	1.01	1.02
170	0.99	1.00	1.00	1.00	1.01
172	.99	1.00	1.00	1.00	1.01
174	.99	0.99	1.00	1.00	1.00
176	.99	.99	0.99	1.00	1.00
178	.99	.99	0.99	0.99	1.00

APPENDIX I

COMPASS ADJUSTING

IN Chapter IV we have assumed that the ship's compass will be properly compensated by a professional compass adjuster (p. 43), and that the navigator will thereafter only need to check the adjuster's table of small remaining deviations from time to time during the voyage. This occasional checking is accomplished most easily by observing the sun's azimuth at the same (or very nearly the same) time when a sextant altitude is measured in the regular work of navigating the ship (cf. p. 145).

But it may happen, expecially in the Navy, that the navigator will be his own compass adjuster: he may be required to swing ship (p. 43), and construct a complete table of deviations himself. To do this he will probably compare the sun's compass bearing with its true azimuth after swinging the ship's head successively on a number of different courses. Each time he observes the sun's bearing with a pelorus (p. 44) or other similar instrument, he will record the time by his watch, which should as usual be set to the ship's apparent time (p. 94). But no sextant observations of any kind will be needed; nor will the sun's altitude ordinarily be calculated. For this reason it is impossible to obtain the sun's true azimuth from our Table 11 (p. 284) which requires a knowledge of the altitude, and which is merely intended for checking the compass error by an observation made nearly simultaneously with a sextant observation, as just explained.

For the purposes of the compass adjuster, the sun's true azimuth is most conveniently taken from Publication 71,

U. S. Hydrographic Office, often called the "red" azimuth table.[1] But if this is not available it can be obtained with almost equal ease, and without interpolation, from the Kelvin Table 13 (p. 292), the use of which is in this case greatly simplified because we only need the sun's azimuth, without a "computed altitude" (the K_3 of p. 129), and because the azimuth itself need only be correct to within a degree.

The given quantities of the problem are:

1. The sun's declination, to be taken to the nearest degree only, and without regard to its + or − sign;
2. The ship's known latitude, or D. R. latitude, always taken to the *nearest degree only*, and without regard to sign, except when choosing formulas;
3. The ship's apparent time, taken from the navigator's watch; counted for the present purpose in civil reckoning, A.M. or P.M. (pp. 75, 78); and hereafter called "the time."

We proceed as follows:[2]

OPERATION 1. Enter Table 13 with:

Arg. a_1 = declination,
Arg. b_1 = the time, if it is earlier in the morning than 6 A.M., or earlier in the afternoon than 6 P.M.;
Arg. b_1 = the time subtracted from 12^h, if later than 6, A.M. or P.M., and before use b_1 must be turned into degrees with Table 9 (p. 249). It need be correct to the nearest degree only; and it will always be less than 90°.

Then take from Table 13 the tabular angle K_1, also correct to the nearest degree only.

OPERATION 2. Enter Table 13 a second time with:

Arg. a_2 = the K_1 obtained in Operation 1.

Then, under this a_2, run down the K-column until you find the K_2 which comes nearest to the declination; and from the left-hand argument column take the b_2 which is in the

[1] In using this very extended table, the young navigator will note that the words "declination − same name as − latitude" signify that declination and latitude have the same sign, both + or both −.

[2] This is a modification of the proceeding of p. 127.

same horizontal line with the declination K_2 just found in the K-column.

OPERATION 3. Add b_2 to the given latitude, and call it the *sum*. Also take the *difference*,[1] between b_2 and the latitude, subtracting the smaller from the larger. Then enter Table 13 a third time with:

Arg. $a_3 = K_1$, again as obtained in Operation 1.

(5′) Arg. $b_3 = 90° -$ above *sum*, if latitude and declination are of opposite signs, one + and one −.

(6′) Arg. $b_3 =$ above *sum* $- 90°$, if the time was later than 6 P.M. in the afternoon, or earlier than 6 A.M. in the morning.

(7′) Arg. $b_3 = 90° -$ above *difference*, in all other cases.

Then with the arguments a_3 and b_3, take from Table 13 the tabular Q_3, the sun's true azimuth, to the nearest degree. If the latitude is +, this azimuth Q_3 is to be counted from the north point of the horizon if we used formula (6′) just given; or if, in using formula (7′), b_2 was greater than the latitude; otherwise Q_3 is to be counted from the south point of the horizon. (If the latitude is −, interchange the north and south points of the horizon in these directions.[2]) And in all latitudes, the azimuth will of course be counted toward the east or west, according as the time was A.M. or P.M.

The foregoing will enable the navigator to obtain the sun's true azimuth from Table 13, either for compass adjusting purposes, or in case he should ever wish to know the azimuth when no altitude has been observed. The following are examples: Given:

1. Dec. = + 8°; D. R. lat. = + 38°; ship's apparent time = $4^h\ 10^m$, P.M.; ship's head by compass = 165°; observed bearing of sun = 240°.5.

[1] The *sum* and *difference* are not both needed; usually only one of the two will be written down.

[2] It will not usually be necessary to consider these directions about Q_3, because the navigator will generally know whether the sun bore N. or S. of the E. or W. point of the horizon at the time of observation.

Larger Bearing	Smaller Bearing 42°	44°	46°	48°	50°
72°	1.34	1.48	1.64	1.83	2.04
74	1.26	1.39	1.53	1.70	1.88
76	1.20	1.31	1.44	1.58	1.75
78	1.14	1.24	1.36	1.49	1.63
80	1.09	1.18	1.28	1.40	1.53
82	1.04	1.13	1.22	1.33	1.45
84	1.00	1.08	1.17	1.26	1.37
86	0.96	1.04	1.12	1.21	1.30
88	.93	1.00	1.08	1.16	1.24
90	.90	0.97	1.04	1.11	1.19
92	.87	.93	1.00	1.07	1.14
94	.85	.91	0.97	1.03	1.10
96	.83	.88	.94	1.00	1.06
98	.81	.86	.91	0.97	1.03
100	.79	.84	.89	.94	1.00
102	.77	.82	.87	.92	0.97
104	.76	.80	.85	.90	.95
106	.74	.79	.83	.88	.92
108	.73	.77	.81	.86	.90
110	.72	.76	.80	.84	.88
112	.71	.75	.79	.83	.87
114	.70	.74	.78	.81	.85
116	.70	.73	.77	.80	.84
118	.69	.72	.76	.79	.83
120	.68	.72	.75	.78	.82
122	.68	.71	.74	.77	.81
124	.68	.71	.74	.77	.80
126	.67	.70	.73	.76	.79
128	.67	.70	.73	.75	.78
130	.67	.70	.72	.75	.78
132	.67	.70	.72	.75	.77
134	.67	.69	.72	.74	.77
136	.67	.70	.72	.74	.77
138	.67	.70	.72	.74	.77
140	.68	.70	.72	.74	.77
142	.68	.70	.72	.74	.77
144	.68	.71	.73	.75	.77
146	.69	.71	.73	.75	.77
148	.70	.72	.74	.76	.77
150	.70	.72	.74	.76	.78
152	.71	.73	.75	.77	.78
154	.72	.74	.76	.77	.79
156	.73	.75	.77	.78	.80
158	.74	.76	.78	.79	.81
160	.76	.77	.79	.80	.82
162	.77	.79	.80	.81	.83
164	.79	.80	.81	.83	.84
166	.81	.82	.83	.84	.85
168	.83	.84	.85	.86	.87
170	.85	.86	.87	.88	.88
172	.87	.88	.89	.90	.90
174	.90	.91	.91	.92	.92
176	.93	.93	.94	.94	.95
178	.96	.97	.97	.97	.97

Larger Bearing	Smaller Bearing 52°	54°	56°	58°	60°
82°	1.58	1.72	1.89	2.08	2.31
84	1.49	1.62	1.77	1.93	2.13
86	1.41	1.53	1.66	1.81	1.98
88	1.34	1.45	1.56	1.70	1.84
90	1.28	1.38	1.48	1.60	1.73
92	1.23	1.31	1.41	1.52	1.63
94	1.18	1.26	1.35	1.44	1.55
96	1.13	1.21	1.29	1.38	1.47
98	1.10	1.16	1.24	1.32	1.41
100	1.06	1.12	1.19	1.27	1.35
102	1.03	1.09	1.15	1.22	1.29
104	1.00	1.06	1.12	1.18	1.25
106	0.97	1.03	1.09	1.14	1.20
108	.95	1.00	1.05	1.11	1.17
110	.93	0.98	1.02	1.08	1.13
112	.91	.95	1.00	1.05	1.10
114	.89	.93	0.98	1.02	1.07
116	.88	.92	.96	1.00	1.04
118	.86	.90	.94	0.98	1.02
120	.85	.89	.91	.96	1.00
122	.84	.87	.90	.95	0.98
124	.83	.86	.90	.93	.96
126	.82	.85	.88	.91	.95
128	.81	.84	.87	.90	.93
130	.81	.83	.86	.89	.92
132	.80	.83	.85	.88	.91
134	.80	.82	.85	.87	.90
136	.80	.82	.84	.87	.89
138	.79	.81	.84	.86	.89
140	.79	.81	.83	.86	.88
142	.79	.81	.83	.85	.87
144	.79	.81	.83	.85	.87
146	.79	.81	.83	.85	.87
148	.79	.81	.83	.85	.87
150	.80	.81	.83	.85	.87
152	.80	.82	.83	.85	.87
154	.81	.82	.84	.85	.87
156	.81	.83	.84	.86	.87
158	.82	.83	.85	.86	.87
160	.83	.84	.85	.86	.88
162	.84	.85	.86	.87	.89
164	.85	.86	.87	.88	.89
166	.86	.87	.88	.89	.90
168	.88	.89	.90	.90	.91
170	.89	.90	.90	.91	.92
172	.91	.92	.91	.93	.93
174	.93	.93	.94	.95	.95
176	.95	.95	.96	.96	.96
178	.97	.98	.98	.98	.98

Larger Bearing	Smaller Bearing 62°	64°	66°	68°	70°
92°	1.77	1.91	2.08	2.28	2.51
94	1.67	1.80	1.95	2.12	2.31
96	1.58	1.70	1.83	1.97	2.14
98	1.50	1.61	1.72	1.85	2.00
100	1.43	1.53	1.63	1.75	1.88
102	1.37	1.46	1.55	1.66	1.77
104	1.32	1.40	1.48	1.58	1.68
106	1.27	1.34	1.42	1.51	1.60
108	1.23	1.29	1.37	1.44	1.53
110	1.19	1.25	1.32	1.39	1.46
112	1.15	1.21	1.27	1.33	1.40
114	1.12	1.17	1.23	1.29	1.35
116	1.09	1.14	1.19	1.25	1.31
118	1.07	1.11	1.16	1.21	1.26
120	1.04	1.08	1.13	1.18	1.23
122	1.02	1.06	1.10	1.15	1.19
124	1.00	1.04	1.08	1.12	1.16
126	0.98	1.02	1.05	1.09	1.13
128	.97	1.00	1.03	1.07	1.11
130	.95	0.98	1.02	1.05	1.09
132	.94	.97	1.00	1.03	1.06
134	.93	.96	0.99	1.01	1.04
136	.92	.95	.97	1.00	1.03
138	.91	.94	.96	0.99	1.01
140	.90	.93	.95	.97	1.00
142	.90	.92	.94	.96	0.99
144	.89	.91	.93	.96	.98
146	.89	.91	.93	.95	.97
148	.89	.90	.92	.94	.96
150	.88	.90	.92	.94	.95
152	.88	.90	.92	.93	.95
154	.88	.90	.91	.93	.94
156	.89	.90	.91	.93	.94
158	.89	.90	.91	.93	.94
160	.89	.90	.91	.93	.94
162	.90	.91	.92	.93	.94
164	.90	.91	.92	.93	.94
166	.91	.92	.93	.93	.94
168	.92	.93	.93	.94	.94
170	.93	.94	.94	.95	.95
172	.94	.95	.95	.96	.96
174	.95	.96	.96	.96	.97
176	.97	.97	.97	.97	.98
178	.98	.98	.99	.99	.99

Larger Bearing	Smaller Bearing 72°	74°	76°	78°	80°
102°	1.90	2.05	2.21	2.40	2.63
104	1.79	1.92	2.07	2.23	2.42
106	1.70	1.81	1.94	2.08	2.25
108	1.62	1.72	1.83	1.96	2.10
110	1.54	1.64	1.74	1.85	1.97
112	1.48	1.56	1.65	1.75	1.86
114	1.42	1.50	1.58	1.66	1.76
116	1.37	1.44	1.51	1.59	1.68
118	1.32	1.38	1.45	1.52	1.60
120	1.28	1.34	1.40	1.46	1.53
122	1.24	1.29	1.35	1.41	1.47
124	1.21	1.25	1.31	1.36	1.42
126	1.18	1.22	1.27	1.32	1.37
128	1.15	1.19	1.23	1.28	1.33
130	1.12	1.16	1.20	1.24	1.29
132	1.10	1.13	1.17	1.21	1.25
134	1.08	1.11	1.14	1.18	1.22
136	1.06	1.09	1.12	1.15	1.19
138	1.04	1.07	1.10	1.13	1.16
140	1.03	1.05	1.08	1.11	1.14
142	1.01	1.04	1.06	1.09	1.12
144	1.00	1.02	1.05	1.07	1.10
146	0.99	1.01	1.03	1.05	1.08
148	.98	1.00	1.02	1.04	1.06
150	.97	0.99	1.01	1.03	1.05
152	.97	.98	1.00	1.02	1.04
154	.96	.98	0.99	1.01	1.02
156	.96	.97	.99	1.00	1.01
158	.95	.97	.98	0.99	1.01
160	.95	.96	.98	.99	1.00
162	.95	.96	.98	.99	1.00
164	.95	.96	.98	.99	0.99
166	.96	.96	.98	.99	.99
168	.96	.96	.98	.99	.99
170	.97	.97	.98	.99	.99
172	.97	.97	.99	.99	.99
174	.98	.98	.99	.99	.99
176	.99	.98	.99	.99	.99
178	.99	.99	.99	.99	.99

Larger Bearing	Smaller Bearing				
	82°	84°	86°	88°	90°
112°	1.98	2.12	2.28	2.46	2.67
114	1.87	1.99	2.12	2.28	2.46
116	1.77	1.88	2.00	2.13	2.28
118	1.68	1.78	1.88	2.00	2.13
120	1.61	1.69	1.78	1.89	2.00
122	1.54	1.62	1.70	1.79	1.89
124	1.48	1.55	1.62	1.70	1.79
126	1.43	1.48	1.55	1.62	1.70
128	1.38	1.43	1.49	1.55	1.62
130	1.33	1.38	1.44	1.49	1.56
132	1.29	1.34	1.39	1.44	1.49
134	1.26	1.30	1.34	1.39	1.44
136	1.22	1.26	1.30	1.34	1.39
138	1.19	1.23	1.27	1.30	1.35
140	1.17	1.20	1.23	1.27	1.31
142	1.14	1.17	1.20	1.24	1.27
144	1.12	1.15	1.18	1.21	1.24
146	1.10	1.13	1.15	1.18	1.21
148	1.08	1.11	1.13	1.15	1.18
150	1.07	1.09	1.11	1.13	1.15
152	1.05	1.07	1.09	1.11	1.13
154	1.04	1.06	1.08	1.09	1.11
156	1.03	1.05	1.06	1.08	1.09
158	1.02	1.03	1.05	1.06	1.08
160	1.01	1.02	1.04	1.05	1.06
162	1.00	1.01	1.03	1.03	1.05
164	1.00	1.00	1.02	1.02	1.04
166	1.00	1.00	1.01	1.02	1.03
168	1.00	1.00	1.00	1.01	1.02
170	0.99	1.00	1.00	1.00	1.01
172	.99	1.00	1.00	1.00	1.01
174	.99	0.99	1.00	1.00	1.00

APPENDIX 1'

COMPASS ADJUSTING

In Chapter IV we have assumed that the ship's compass will be properly compensated by a professional compass adjuster (p. 43), and that the navigator will thereafter only need to check the adjuster's table of small remaining deviations from time to time during the voyage. This occasional checking is accomplished most easily by observing the sun's azimuth at the same (or very nearly the same) time when a sextant altitude is measured in the regular work of navigating the ship (cf. p. 145).

But it may happen, expecially in the Navy, that the navigator will be his own compass adjuster: he may be required to swing ship (p. 43), and construct a complete table of deviations himself. To do this he will probably compare the sun's compass bearing with its true azimuth after swinging the ship's head successively on a number of different courses. Each time he observes the sun's bearing with a pelorus (p. 44) or other similar instrument, he will record the time by his watch, which should as usual be set to the ship's apparent time (p. 94). But no sextant observations of any kind will be needed; nor will the sun's altitude ordinarily be calculated. For this reason it is impossible to obtain the sun's true azimuth from our Table 11 p. 284) which requires a knowledge of the altitude, and which is merely intended for checking the compass error by an observation made nearly simultaneously with a sextant observation, as just explained.

For the purposes of the compass adjuster, the sun's true azimuth is most conveniently taken from Publication 71,

U. S. Hydrographic Office, often called the "red" azimuth table.[1] But if this is not available it can be obtained with almost equal ease, and without interpolation, from the Kelvin Table 13 (p. 292), the use of which is in this case greatly simplified because we only need the sun's azimuth, without a "computed altitude" (the K_3 of p. 129), and because the azimuth itself need only be correct to within a degree.

The given quantities of the problem are:

1. The sun's declination, to be taken to the nearest degree only, and without regard to its + or − sign;
2. The ship's known latitude, or D. R. latitude, always taken to the *nearest degree only*, and without regard to sign, except when choosing formulas;
3. The ship's apparent time, taken from the navigator's watch; counted for the present purpose in civil reckoning, A.M. or P.M. (pp. 75, 78); and hereafter called "the time."

We proceed as follows:[2]

OPERATION 1. Enter Table 13 with:

Arg. a_1 = declination,
Arg. b_1 = the time, if it is earlier in the morning than 6 A.M., or earlier in the afternoon than 6 P.M.;
Arg. b_1 = the time subtracted from 12^h, if later than 6, A.M. or P.M., and before use b_1 must be turned into degrees with Table 9 (p. 249). It need be correct to the nearest degree only; and it will always be less than 90°.

Then take from Table 13 the tabular angle K_1, also correct to the nearest degree only.

OPERATION 2. Enter Table 13 a second time with:

Arg. a_2 = the K_1 obtained in Operation 1.

Then, under this a_2, run down the K-column until you find the K_2 which comes nearest to the declination; and from the left-hand argument column take the b_2 which is in the

[1] In using this very extended table, the young navigator will note that the words "declination – same name as – latitude" signify that declination and latitude have the same sign, both + or both −.

[2] This is a modification of the proceeding of p. 127.

same horizontal line with the declination K_2 just found in the K-column.

OPERATION 3. Add b_2 to the given latitude, and call it the *sum*. Also take the *difference*,[1] between b_2 and the latitude, subtracting the smaller from the larger. Then enter Table 13 a third time with:

Arg. $a_3 = K_1$, again as obtained in Operation 1.
(5′) Arg. $b_3 = 90° -$ above *sum*, if latitude and declination are of opposite signs, one + and one −.
(6′) Arg. $b_3 =$ above *sum* $- 90°$, if the time was later than 6 P.M. in the afternoon, or earlier than 6 A.M. in the morning.
(7′) Arg. $b_3 = 90° -$ above *difference*, in all other cases.

Then with the arguments a_3 and b_3, take from Table 13 the tabular Q_3, the sun's true azimuth, to the nearest degree. If the latitude is +, this azimuth Q_3 is to be counted from the north point of the horizon if we used formula (6′) just given; or if, in using formula (7′), b_2 was greater than the latitude; otherwise Q_3 is to be counted from the south point of the horizon. (If the latitude is −, interchange the north and south points of the horizon in these directions.[2]) And in all latitudes, the azimuth will of course be counted toward the east or west, according as the time was A.M. or P.M.

The foregoing will enable the navigator to obtain the sun's true azimuth from Table 13, either for compass adjusting purposes, or in case he should ever wish to know the azimuth when no altitude has been observed. The following are examples: Given:

1. Dec. = + 8°; D. R. lat. = + 38°; ship's apparent time = $4^h\ 10^m$, P.M.; ship's head by compass = 165°; observed bearing of sun = 240°.5.

[1] The *sum* and *difference* are not both needed; usually only one of the two will be written down.

[2] It will not usually be necessary to consider these directions about Q_3, because the navigator will generally know whether the sun bore N. or S. of the E. or W. point of the horizon at the time of observation.

Operation 1 gives $a_1 = 8°$; $b_1 = 4^h\ 10^m = 62\frac{1}{2}°$ (p. 249); $K_1 = 61°$(p. 295);

Operation 2 gives $a_2 = 61°$; $K_2 = 8°$; $b_2 = 17°$ (p. 308);

Operation 3 gives *sum* $= 55°$; *difference* $= 21°$; $a_3 = 61°$; $b_3 = 69°$; $Q_3 = 79°$; sun's azimuth = S 79° W = 259°.

The red tables, p. 88, give N 101° W. = 259°. Then by formula (2), p. 45, we have: $E = T - C = 259° - 240°.5 = +18°.5$ = compass error. And if we take the variation to be $+10°$, as on p. 48, we have by formula (1), p. 45, $D = E - V = 18°.5 - 10° = +8°.5$ = the deviation when the bearing of the ship's head by compass was 165°. This deviation is the same as is given in the table on p. 48.

2. Dec. $= -8°$; D. R. lat. $= +38°$; time $= 7^h\ 50^m$, A.M.; ship's head by compass $= 75°$; compass bearing of sun $= 114°$; $a_1 = 8°$; $b_1 = 12^h - 7^h\ 50^m = 4^h\ 10^m = 62\frac{1}{2}°$; $K_1 = 61°$; $a_2 = 61°$; $K_2 = 8°$; $b_2 = 17°$; *sum* $= 55°$; *diff.* $= 21°$; $a_3 = 61°$; $b_3 = 35°$; $Q_3 =$ S 66°E = 114°.

   The red tables also give 114° for the sun's azimuth, affording an excellent check on the work. Now the compass error $E = T - C = 114° - 114° = 0°$. With $V = +10°$, $D = E - V = 0° - 10° = -10°$. The table on p. 48 gives $D = -9°.7$.

3. Dec. $= +15°$; D. R. lat. $= +38°$; time $= 5^h\ 40^m$, A.M.; ship's head by compass $= 225°$; compass bearing of sun $= 39°$; $a_1 = 15°$; $b_1 = 5^h\ 40^m = 85°$; $K_1 = 74°$; $a_2 = 74°$; $K_2 = 15°$; $b_2 = 70°$; *sum* $= 108°$; *diff.* $= 32°$; $a_3 = 74°$; $b_3 = 18°$; $Q_3 =$ N 75° E = 75°.

   The red tables also give 75° for the sun's azimuth. And the compass error $E = T - C = 75° - 39° = 36°$. With $V = +10°$, $D = E - V = 36° - 10° = +26°$. The table on p. 48 gives $D = +25°.6$.

In this way the entire deviation table of p. 48 might have been obtained from observations, and the Second Deviation Table (p. 49) subsequently computed.

In connection with these two deviation tables, it may be of interest to supplement p. 49 by emphasizing once more that both tables are needed in correct navigation. The second table is necessary for changing a true course into a compass course for the helmsman (see p. 143 for an example): and the first table (in coastwise navigation) for correcting a re-

versed bearing (p. 55), or fixing a ship's position by cross bearings (p. 56). Only if the compass has been very well compensated or adjusted is it permissible to navigate with one table only. With a compass thus compensated the outstanding deviations would be so small that the two tables would be practically interchangeable. Were it possible to effect a perfect compensation, the two tables would be identical, and all the deviations of both would be 0°.

Having now explained the method of determining deviations without measuring or calculating the sun's altitude, we shall next consider in a practical way the principal problem of compass adjusting, or the placing of magnetic and other correctors in position, so as to minimize the deviation on all courses. We shall begin with certain definitions.

1. Semicircular deviation is that part of the total deviation which is corrected by two permanent magnets (or bundles of thin magnets) placed in the lower part of the binnacle. One of these permanent magnets is always placed in a fore-and-aft position, the other in a thwartship position. Both may be raised and lowered, so as to change their distances from the compass card. The north (or north-seeking) ends of all permanent magnets are always painted red.

2. Quadrantal deviation is that part of the total deviation which is corrected with two hollow iron spheres or other pieces of iron placed on each side of the compass bowl in an athwartship direction. They are adjustable in position, so that their distances from the compass card can be varied.

3. The heeling error is an additional deviation caused by the ship's rolling, and is corrected with an additional permanent magnet placed in a vertical position directly under the center of the compass bowl.

4. The following procedure may be used on a compass entirely uncompensated, or on a compass already approximately compensated, either by actual observations, or by the placing of magnets in approximate positions suggested

by experience. The method is specially designed to avoid the necessity of steering directly by the sun,[1] by ranges of known bearing, or by means of a "Napier diagram," in the course of the adjustment.

5. With the ship on an even keel and all permanent magnets being removed, begin by moving the vertical heeling magnet from top to bottom of its travel. This should not affect the compass card at all. If it does, the compass bowl is itself not properly centered in the binnacle, and its position there must be adjusted by the proper adjusting screws.

6. After the preliminary centering under 5, remove the heeling magnet to a distance, and place the two iron spheres in an approximately proper position, suggested by experience; or, if lacking experience, place them in the middle positions permitted by their respective ranges of adjustment.

7. Next you must learn how to head your ship on any desired *magnetic* course, say M. To do this, let G represent any convenient auxiliary number of degrees. In a steel ship, with compass entirely uncompensated, we might put $G = 15°$. In a wooden ship, or for a compass already approximately compensated, we might take $G = 10°$, or even less. In general, G should be about half as large as the largest remaining deviations the compass is expected to have.

Now steady the ship on the compass course $M - G$, and keep her steady on that course by heading for some object ashore, or by careful use of the compass. While running slowly on that course, observe the sun's compass bearing and note the ship's apparent time by your watch. The watch should be set in advance to ship's apparent time (see p. 94).

Then, with the red azimuth tables, or the Kelvin table, ascertain the true bearing of the sun, which we will call T, and calculate the compass error $E = T - (M - G)$. The variation, V, being taken from the chart, you will have the

[1] "Maneuver the ship with the helm until the sun comes on the sight vanes (of the pelorus)." Bowditch, p. 51, 1916 edition.

deviation $D = T - (M - G) - V$. Call this deviation d_1 (it corresponds to the compass course $M - G$).

Now steady the ship on a new compass course $M + G$, and determine by observation in exactly the same way a new deviation, which call d_2.

You will then have:

For ship's head by compass	the deviation
$M - G$,	d_1,
$M + G$,	d_2,

Then the deviation for the magnetic course M, which we desire to find, and which we will call d_M, will be:

$$d_M = \frac{G(d_2 + d_1)}{2\,G + d_2 - d_1};$$

And the required compass course, C_M, corresponding to the given magnetic course M, will be:

$$C_M = M - d_M.$$

The value of d_M may be taken from the accompanying little Table in all cases that are likely to arise in actual work. Should a number ever be required from a blank place in the Table, the compass probably has unusual deviations, and a preliminary partial compensation should be attempted by means of known ranges taken from a chart.

8. Go through the work under 7 for the magnetic course $M = 0°$ (or due north). If you take $G = 15°$, this will necessitate determining by observation the deviations d_1 and d_2 for the compass courses $0° - 15° = 345°$, and $0° + 15° = 15°$ (see example, p. 333).

You will then calculate d_0 and C_0, the deviation and compass course corresponding to the magnetic course 0°, using the above formula for d_M, which in this case is d_0; or you will take d_0 directly from the Table.

9. Steady your ship on this compass course C_0 (or magnetic course $M = 0°$), and keep her quite steady by heading for a visible fixed point like a light-house, or by using tem-

Values of d_M, the Deviation for the Magnetic Course M

$G = 15°$

d_1, Dev'n for Com. Course $M-G$.	d_2, the Deviation for the Compass Course $M+G$												
	−30°	**−25°**	**−20°**	**−15°**	**−10°**	**−5°**	**0°**	**+5°**	**+10°**	**+15°**	**+20°**	**+25°**	**+30°**
−30°	−30°	−24°	−19°	−15°	−12°	−10°	− 8°	− 6°	− 4°	− 3°	− 2°	− 1°	0°
−25	−33	−25	−19	−15	−12	− 9	− 7	− 5	− 4	− 2	− 1	0	+ 1
−20		−27	−20	−15	−11	− 8	− 6	− 4	− 2	− 1	0	+ 1	+ 2
−15		−30	−21	−15	−11	− 8	− 5	− 3	− 1	0	+ 1	+ 2	+ 3
−10			−22	−15	−10	− 6	− 4	− 2	0	+ 1	+ 2	+ 4	+ 4
− 5			−25	−15	− 9	− 5	− 2	0	+ 2	+ 3	+ 4	+ 5	+ 6
0			−30	−15	− 8	− 3	0	+ 2	+ 4	+ 5	+ 6	+ 7	+ 8
+ 5				−15	− 5	0	+ 3	+ 5	+ 6	+ 8	+ 8	+ 9	+10
+10	+30			−15	0	+ 5	+ 8	+ 9	+10	+11	+11	+12	+12
+15	+15	+15	+15	0	+15	+15	+15	+15	+15	+15	+15	+15	+15
+20	+ 8	+ 5	0	−15			+30	+25	+22	+21	+20	+19	+19
+25	+ 3	0	− 5	−15					+35	+30	+27	+25	+23
+30	0	− 3	− 8	−15	−30							+33	+30

$G = 10°$

d_1, Dev'n for Com. Course $M-G$.	d_2, the Deviation for the Compass Course $M+G$												
	−30°	**−25°**	**−20°**	**−15°**	**−10°**	**−5°**	**0°**	**+5°**	**+10°**	**+15°**	**+20°**	**+25°**	**+30°**
−30°	−30°	−22°	−17°	−13°	−10°	− 8°	− 6°	− 5°	− 3°	− 2°	− 1°	− 1°	0°
−25	−37	−25	−18	−13	−10	− 8	− 6	− 4	− 3	− 2	− 1	0	+ 1
−20		−30	−20	−14	−10	− 7	− 5	− 3	− 2	− 1	0	+ 1	+ 1
−15			−23	−15	−10	− 7	− 4	− 3	− 1	0	+ 1	+ 2	+ 2
−10			−30	−17	−10	− 6	− 3	− 1	0	+ 1	+ 2	+ 3	+ 3
− 5				−20	−10	− 5	− 2	0	+ 1	+ 2	+ 3	+ 4	+ 4
0	+30			−30	−10	− 3	0	+ 2	+ 3	+ 4	+ 5	+ 6	+ 6
+ 5	+17	+20	+30		−10	0	+ 3	+ 5	+ 6	+ 7	+ 7	+ 8	+ 8
+10	+10	+10	+10	+10	0	+10	+10	+10	+10	+10	+10	+10	+10
+15	+ 6	+ 5	+ 3	0	−10		+30	+20	+17	+15	+14	+13	+13
+20	+ 3	+ 2	0	− 3	−10	−30			+30	+23	+20	+18	+17
+25	+ 1	0	− 2	− 5	−10	−20					+30	+25	+22
+30	0	− 1	− 3	− 6	−10	−17	−30						+30

$G = 5°$

d_1, Dev'n for Com. Course $M-G$.	d_2, the Deviation for the Compass Course $M+G$												
	−30°	**−25°**	**−20°**	**−15°**	**−10°**	**−5°**	**0°**	**+5°**	**+10°**	**+15°**	**+20°**	**+25°**	**+30°**
−30°	−30°	−18°	−12°	− 9°	− 7°	− 5°	− 4°	− 3°	− 2°	− 1°	− 1°	0°	0°
−25		−25	−15	−10	− 7	− 5	− 4	− 2	− 2	− 1	0	0	0
−20			−20	−12	− 8	− 5	− 3	− 2	− 1	− 1	0	0	+ 1
−15			−35	−15	− 8	− 5	− 3	− 2	− 1	0	+ 1	+ 1	+ 1
−10	+20	+35		−25	−10	− 5	− 2	− 1	0	+ 1	+ 1	+ 2	+ 2
− 5	+12	−15	+25		−15	− 5	− 2	0	+ 1	+ 2	+ 2	+ 2	+ 3
0	+ 8	+ 8	+10	+15		− 5	0	+ 2	+ 2	+ 3	+ 3	+ 4	+ 4
+ 5	+ 5	+ 5	+ 5	+ 5	+ 5	0	+ 5	+ 5	+ 5	+ 5	+ 5	+ 5	+ 5
+10	+ 3	+ 3	+ 2	+ 2	0	− 5		+15	+10	+ 8	+ 8	+ 7	+ 7
+15	+ 2	+ 2	+ 1	0	− 2	− 5	−15		−25	+15	+12	+10	+ 9
+20	+ 1	+ 1	0	− 1	− 2	− 5	−10	−25			+20	+15	+12
+25	+ 1	0	− 1	− 2	− 3	− 5	− 8	−15	−35			+25	+18
+30	0	− 1	− 1	− 2	− 3	− 5	− 8	−12	−20				+30

porarily an auxiliary compass. But this auxiliary compass must not be near enough to the magnets to be influenced by them.

10. Move the thwartship permanent correcting magnet toward or from the compass bowl, until the lubber line (p. 42) is on the correct magnetic course 0°. If you are working with a compass as yet entirely uncompensated, for which the permanent magnets have not even been placed in the binnacle, the thwartship one should be located with its red end to starboard, if the d_0 found under 8 was *plus*, or easterly deviation; and with its red end to port, if that d_0 was *minus*, or westerly deviation.

11. Go through the work under 7 again for the magnetic course $M = 90°$ (or due east). This will necessitate determining by observation the deviations for the compass courses 75° and 105°, if you are working with $G = 15°$. And you will calculate d_{90} and C_{90}, the deviation and compass course for the magnetic course 90°.

12. Now steady the ship on the compass course C_{90}, and place the fore-and-aft compensating permanent magnet with its red end forward, if the d_{90} found under 11 was *plus*, and with its red end aft, if d_{90} was *minus*. Adjust the magnet so as to make the compass read 90°. Your semicircular deviation is now corrected.

13. Go through the work under 7 for the magnetic course $M = 45°$ (or north-east, magnetic). This will necessitate observing the sun on the compass courses 30° and 60°; and will give you d_{45} and C_{45}, the deviation and compass course corresponding to magnetic course 45°.

14. Steady your ship on the compass course C_{45}, and move the two spheres in and out until the lubber line is on 45°, leaving the two spheres finally so placed that they are equally distant from the compass bowl. Your quadrantal deviation is now corrected.

15. To compensate for heeling error, head the ship approximately north or south, and keep her accurately on that

course by heading slowly for an object ashore. Now heel the vessel about 10°, by any convenient method.

If the north-seeking end of the compass card is thereby deviated toward the high side of the ship, place the heeling corrector with red end up in such a position as will bring the compass card back where it was before ship was heeled. If the compass card was deviated toward the low side of the ship, place the heeling corrector with the red end down.

16. The "Flinders bar" is a vertical bar of soft iron (or a combination of several bars) sometimes placed directly forward or aft of the compass. It will correct a certain part of the semicircular deviation not fully removed by the permanent magnets adjusted under 10 and 12. Usually a Flinders bar is best located by placing it in a position suggested by experience; but many compasses are adjusted without such a bar, and when there is none, the magnets usually need readjustment whenever the ship changes her latitude very considerably.

17. After completing the adjustment, it is well to swing ship on eight equidistant courses, and check the deviation table by new observations.

18. After a compass has once been adjusted, necessary minor changes of the magnets and spheres can be most conveniently made as follows. Head the ship north, and steady her with an auxiliary compass, or by means of a conspicuous object ashore. Then move the athwartship magnet up one inch, and note by the compass bearing of the sun how much the compass has changed, and in which direction. The same thing can be done with the fore-and-aft magnets by heading the ship east; and with the spheres by heading northeast. Having thus ascertained how much the compass is changed by a one-inch motion of each corrector, it is easy to calculate how much they should each be moved to compensate for any outstanding small deviations on the north, east, and northeast magnetic courses. Corrections can thus be made at any time during a voyage, if the deviations become unduly large.

When the magnets are not movable, but consist of fixed bundles of thin wire magnets, all adjustments throughout are made by increasing or diminishing the number of wires, instead of moving the magnets toward the compass bowl or away from it.

Notes

Note to 8. You can equally well head the ship south instead of north, and go through the work for $M = 180°$, instead of $M = 0°$.

Note to 10. If you head south, according to the Note to 8, the red end of the thwartship magnet must lie reversed.

Note to 11. This work may be done before that under 8, if desired.

Note to 12. You may head the ship west, if you wish, instead of east, and work for $M = 270°$, instead of 90°. The magnet must then be placed with red end aft, to correct *plus* deviation.

Note to 14. This may equally well be done for $M = 135°$, 225°, or 315°.

Note to 18. The above notes to 12 and 14 also apply to 18.

General Note. Whenever an adjustment can be made on two opposite courses, as indicated in the above Notes, accuracy will be increased by adjusting on *both* courses, and leaving the correctors finally in the average of the two positions found.

EXAMPLE

Consider the compass for which the two deviation tables (pp. 48, 49) hold good; and we shall suppose it to have been a totally uncompensated compass.

Under 8 and 7, putting $M = 0°$, $G = 15°$, we have:
for compass course $M - G = 345°$, $d_1 = -16°.0$ (table, p. 48),
for compass course $M + G = 15°$, $d_2 = -14°.9$ (table, p. 48).

$$\text{Then, } d_M = d_0 = \frac{G(d_2+d_1)}{2G+d_2-d_1} = \frac{15\times(-30.9)}{30-14.9+16.0} = -\frac{463.5}{31.1} = -14°.9.$$

This $-14°.9$ is in exact agreement with the d_0 given in the second deviation table (p. 49), for the magnetic course $M = 0°$. The

agreement would not always be as perfect. The $-14°.9$ must now be corrected with the thwartship magnet as directed under 10.

Next, under 11, for $M = 90°$, we have:
for compass course $M - G = 75°$, $d_1 = -9°.7$ (table, p. 48),
for compass course $M + G = 105°$, $d_2 = -9°.0$ (table, p. 48).

$$\text{Then, } d_M = d_{90} = \frac{G(d_2+d_1)}{2G+d_2-d_1} = \frac{15\times(-18.7)}{30-9.0+9.7} = -\frac{280.5}{30.7} = -9°.1.$$

The $-9°.1$ agrees closely with $-9°.0$, given in the second deviation table (p. 49) for $M = 90°$. It must be corrected as directed under 12. This completes the ordinary semicircular compensation.

Coming now to 13, with $M = 45°$, we must observe the sun on the compass courses 30° and 60°. But the semicircular correction being now complete, the observed deviations will no longer agree with those given in the table, which are supposed to have been observed with a compass entirely uncompensated.

Let us suppose the observations gave the following results:

for compass course $M - G = 30°$, $d_1 = +6°.9$,
for compass course $M + G = 60°$, $d_2 = +6°.0$.

$$\text{Then, } d_M = d_{45} = \frac{G(d_2+d_1)}{2G+d_2-d_1} = \frac{15\times 12.9}{30+6.0-6.9} = +\frac{193.5}{29.1} = +6°.6.$$

This 6°.6 must now be corrected as directed under 14, completing the quadrantal compensation.

APPENDIX 2

EX-MERIDIAN AND MISCELLANEOUS EXAMPLES

EX-MERIDIAN observations (p. 99) are completely and accurately calculated with the Kelvin Table 13, working out a Sumner line (see p. 148 for an example). But if a rapid calculation of the ship's *latitude only* is desired, we may either use special tables (p 99, footnote), or, if these are not available, we may apply the Kelvin Table with but little additional labor and almost equal accuracy We may still use the simplified method already explained in Appendix 1 (p. 324); except that Q_3 will not now be required, and K_2 as well as K_3 must be taken from the Table exact to the nearest minute (see Ex. 1) This having been done, the ship's latitude, *at the moment of observation*, may be quickly calculated from the ex-meridian altitude by first choosing from p. 89 the formula which would be appropriate for a noon-sight, and then applying to the D. R. latitude (*taken to the nearest degree only*) the two following corrections:

the "altitude correction" = corrected observed altitude $- K_3$;
the "declination correction" = sun's declination $- K_2$.

These corrections are to be added or subtracted, according as the formula chosen from p. 89 had a + or − sign for the altitude and declination respectively. This is the only use here made of the formula.

Young naval officers having commands should give special attention to the foregoing, because they may be required to signal their latitude to the flagship promptly at noon, before they have had time to calculate a noon-sight. In such cases an ex-meridian taken at about $11^h\ 30^m$, ship's apparent time,

and the resulting latitude *carried forward* to noon with the traverse table, will furnish an excellent value for the noon latitude to be signaled. The whole calculation, including the carrying forward to noon, can be completed in a few minutes, and the signal flags bent on, ready to be run up at noon precisely. The navigator will then be free to observe a noon-sight as a check.

As the noon longitude is always signaled as well as the latitude, a time-sight should be observed (if weather permits) in the early morning. This time-sight should be calculated as a Sumner long before noon; and the resulting Sumner line should be carried forward to noon by D. R. methods (p. 137), estimating in advance the probable speed of the ship and her course to noon. An ex-meridian observation made at about $11^h\ 30^m$ (and also carried forward) having furnished the noon latitude, the complete noon position of the ship will be finally fixed at that point of the moved Sumner line which cuts the ship's noon parallel of latitude (see Ex. 4). But when the navigator is not hurried by the necessity of signaling the ship's position at noon, it is better to work out a Sumner line from the morning time-sight, and also from a sight taken near noon (or at noon), and then determine the intersection point of the two Sumner lines in the regular way.

Ex. 1. Observed altitude, 26° 55′; index, + 3′; height of eye, 15 feet; watch time of observation, $11^h\ 42^m\ 0^s$ A.M.; D. R. latitude, to the nearest degree, 39°; D. R. longitude, 73° 58′; *C. – W.*, $4^h\ 51^m\ 42^s$; chron. slow, 4^s; equation, $+\,3^m\ 22^s$; declination, – 23° 24′; find the latitude by the ex-meridian method. (This is the example worked as a Sumner on pp. 148–149.)

The corrected observed altitude comes out 27° 8′; ship's apparent time, $11^h\ 41^m\ 16^s$ A.M.; $a_1 = 23°$; $b_1 = 18^m\ 44^s = 4°\ 41' = 5°$, to the nearest degree; $K_1 = 4°$;[1] $a_2 = 4°$;

[1] The value 4° is the nearest whole degree for K_1, since, in using Table 13, we notice that b_1 was only 4° 41′, and therefore not quite 5°. But our result would be almost as accurate if we continued the calculation with $K_1 = 5°$ (see also Ex. 11).

$K_2 = 22° 56'$ (taken out to the nearest minute); $b_2 = 23°$; $sum = 62°$; $b_3 = 90° - sum = 28°$; $a_3 = 4°$; $K_3 = 27° 56'$ (taken to the nearest minute). We choose formula (4), p. 89, or lat. = 90° − alt. − dec. The altitude correction is 27° 8′ − 27° 56′ = − 48′, which must be subtracted, because alt. is − in the formula. The declination correction is 23° 24′ − 22° 56′ = + 28′, which must also be subtracted, because dec. is also − in the formula. The D. R. latitude being 39°, the final latitude will be 39° − (− 48′) − 28′ = 39° 20′. On p. 149 we found 39° 19′ by the Sumner calculation.

Ex. 2. Corrected observed ex-meridian altitude, 74° 26′; ship's apparent time, $12^h\ 24^m$ P.M.; declination, + 3° 12′; D. R. latitude, + 17° 45′, or, to the nearest degree, + 18°. Find the latitude. *Ans.* 17° 39′.

Ex. 3.[1] Corrected observed ex-meridian altitude, 72° 3′; ship's apparent time, $11^h\ 46^m$ A.M.; declination, + 20° 30′; D. R. latitude, + 3° 5′; find the latitude. *Ans.* 2° 53′.

Ex. 4. At sea, at $9^h\ 42^m\ 28^s$ A.M, by the watch (see p. 146), a time-sight was observed, and worked as a Sumner. It gave a Sumner point in lat. 39° 50′ N., long. 73° 56′ W., bearing of line, 237°. The ship was estimated to be steaming at a speed of 15 knots on a true course of 182°. At $11^h\ 42^m$ an ex-meridian (see Ex. 1) gave the latitude 39° 20′. Find the latitude and longitude to be signalled *at noon.*

Ans. Sumner point carried forward to noon is then in lat. 39° 16′, long. 73° 58′; bearing of line unchanged at 237°.

[1] If the observed altitude is larger than 45°, it is well to be specially careful in taking out K_3. For instance, if K_1 happened to be 3½°, a_2 as well as a_3 would also be 3½°, and we might therefore take K_2 and K_3 from the column headed $a = 3°$ or the column headed $a = 4°$. In the case of sun observations the choice between the two columns will not matter for K_2, but for K_3 it is better to interpolate between the values given in the two adjoining columns in question (see Ex. 3).

It may also help the beginner in choosing between the *sum* and *difference* formulas of p. 325 to remember that the proper formula will always make b_3 come within a degree or two of the observed altitude in the case of ex-meridian observations.

The ex-meridian carried forward to noon gives the ship's noon latitude as 39° 15′ (to be signaled). So the latitude difference at noon between the ship and the Sumner point is 1′, and the bearing of the ship from the Sumner point is 237°.[1] For course 237° and lat. diff. 1′, the Traverse Table gives dep. = 1′.7. The corresponding long. diff. is 2′.2; and so the ship's long. at noon = 73° 58′ + 2′ = 74° 0′ (to be signaled).

Ex. 5. At sea, Sept. 20, 1918, A.M., with D. R. lat. 45° 26′ N.; D. R. long. 21° 40′ W.; at $7^h\ 58^m\ 26^s$, A.M. by the watch, the sun's measured altitude was 22°.7′; index, + 3′; height of eye, 26 feet; *C. − W.* was $1^h\ 26^m\ 20^s$ at 6^h A.M. Sept. 20, and $1^h\ 27^m\ 11^s$ at $9^h\ 26^m$ A.M. of the same date. The chronometer had been compared with a standard ashore, and found to be fast of G. M. T. $0^m\ 26^s$ on Sept. 1 at 10 A.M., and slow of G. M. T. $0^m\ 18^s$ on Sept. 15 at 4 P.M. The 1918 almanac gives:

Sept. 19, 20^h G. M. T., decl., + 1° 22′.4; equation, + $6^m\ 17^s.2$.
Sept. 19, 22^h G. M. T., decl., + 1° 20′.5; equation, + $6^m\ 19^s.0$.
Sept. 20, 0^h G. M. T., decl., + 1° 18′.6; equation, + $6^m\ 20^s.7$.
Sept. 20, 2^h G. M. T., decl., + 1° 16′.6; equation, + $6^m\ 22^s.5$.

Find the longitude of the ship by the time-sight method. *Ans.* At the time of observation *C. − W.* was $1^h\ 26^m\ 49^s.4$; chronometer was slow $0^m\ 32^s.4$; the observation being a forenoon one, the G. M. T. came out $21^h\ 25^m\ 48^s$ of the 19th Sept. (p. 78); by formula (4), p. 100, hav. (24^h − T) was 9.38260; corresponding 24^h − T was $3^h\ 55^m\ 23^s$ (p. 264), and T was $20^h\ 4^m\ 37^s$ (p. 103, footnote); ship's longitude was 21° 52′ W.

Ex. 6. Simultaneously with the altitude measured in Ex. 5, the sun's compass bearing was taken with a pelorus and found to be 123°. The variation was 22° W., by the magnetic chart. Find the deviation. *Ans.* 11° E.

This example may be solved with Table 11 because the altitude has been measured.

Ex. 7. Using the data of Ex. 5, find the ship's noon latitude on Sept. 20, 1918, from a measured noon altitude of 45° 46′. *Ans.* 45° 18′.

Ex. 8. Calculate Ex. 5 as a Sumner by the Kelvin Table.

[1] This would be 237° − 180° if the ship's latitude had come out greater than that of the Sumner point.

Ans. The Sumner point is in latitude 45° 33′; longitude 21° 49′; bearing of the line 22° or 180° + 22°, according to the end of the line to be used.

Ex. 9. From the noon latitude of Ex. 7, and the Sumner line of Ex. 8, find the ship's noon longitude, assuming the ship was steaming at 17 knots on a 168° true course. *Ans.* 21° 2′.

Ex. 10. At sea, from an observation at $8^h\ 28^m$ A.M., ship's apparent time, a Sumner point was computed to be in latitude 28° 26′ N.; longitude 40° 11′ W.; bearing of the line 28° or 208°. Clouds having prevented observation at noon, the latitude was found from an ex-meridian observation to be 27° 17′ at $12^h\ 28^m$ P.M., ship's time. The ship was steaming at 18 knots on a 130° true course. Find the noon latitude and longitude. *Ans.* Latitude, 27° 22′; longitude, 39° 30′.

Ex. 11. With the data of Ex. 1, it is required to prepare in advance for an ex-meridian observation and its calculation.

Since it is intended to make the observation at about $11^h\ 40^m$, ship's time, we begin our preparatory calculations by computing K_2 and K_3 for $11^h\ 36^m$ and $11^h\ 44^m$,[1] ship's time, which correspond to $11^h\ 36^m\ 44^s$ and $11^h\ 44^m\ 44^s$ by the watch[2] We thus obtain:

for $11^h\ 36^m\ 44^s$, declination correction = − 28′, to be subtracted;
alt. correction = alt. − 26° 50′, to be subtracted.
for $11^h\ 44^m\ 44^s$, declination correction = + 28′, to be subtracted;
alt. correction = alt. − 27° 56′, to be subtracted.

This completes the preparatory calculation. In Ex. 1 the actual observation of altitude was made at $11^h\ 42^m$, and the corrected altitude was 27° 8′. Interpolating the declination and altitude corrections for $11^h\ 42^m$, we obtain:

declination correction = + 9′; alt. correction = 27° 8′ − 27° 34′ = − 26′;

both corrections to be subtracted. We then have, finally: Latitude = 39° − 9′ + 26′ = 39° 17′. In Ex. 1 we found 39° 20′, and on p. 149, 39° 19′.

[1] We have chosen 36^m and 44^m so as to have b_1 an exact number of degrees. This increases the accuracy of K_1 (cf. Ex. 1, p. 336, footnote).

[2] We know from the data of Ex. 1 that the watch was 44^s fast of ship's apparent time.

Ex. 12. With the data of Ex. 3, prepare in advance for the calculation. *Ans.* We find:
for $11^h\ 40^m$, declination correction, $-25'$, to be added,
alt. correction $=$ alt. $-71°\ 20'$, to be added;
for $11^h\ 48^m$, declination correction, $-28'$, to be added,
alt. correction $=$ alt. $-71°\ 46'$, to be added;
and for the final latitude $2°\ 52'$. In Ex. 3 we found $2°\ 53'$; but such small differences are not of much importance in navigation calculations.

Ex. 13. Using the data of Ex. 5 and Ex. 9, prepare in advance for the noon-sight of Ex. 7, and its speedy calculation.

Ans. D R. longitude at noon, $21°\ 20'$; watch time of noon, $11^h\ 50^m\ 37^s$; declination at noon, $+1°\ 17'$; D. R. latitude at noon, $44°\ 20'$; formula (p. 89), lat. $= 90° +$ dec. $-$ alt. To get the approximate noon altitude in advance, we invert the formula, and thus obtain an approximate "D. R. alt." $= 90° +$ dec. $-$ D. R. lat. $= 90° + 1°\ 17' - 44°\ 20' = 46°\ 57'$. For this D. R. alt. at noon, we find that Table 6 $+$ Table 7 $= +10'$. Therefore, at noon, lat. $= 90° +$ dec. $-10' -$ observed alt. $-$ index correction, or noon lat. $= 91°\ 4' -$ observed alt. $= 91°\ 4' - 45°\ 46' = 45°\ 18'$. This number ($91°\ 4'$) is often called the "constant." If it has been prepared in advance, the latitude can be calculated in a few moments, after the noon observation has been made at about $11^h\ 50^m\ 37^s$ by the watch.

Ex. 14. With declination $-3°\ 7'$; D. R. noon latitude $+38°\ 17'$; prepare a constant for a noon-sight, and calculate the latitude, supposing that the observed altitude turned out to be $48°\ 17'$, height of eye 20 feet, and index correction $+3'$. *Ans.* D. R. altitude, $48°\ 36'$; lat. $= 86°\ 39' -$ obs'd alt. $= 38°\ 22'$.

Ex. 15. With the data of Ex. 13, and at $11^h\ 30^m$ by the watch, it is required to set it so that it will be correct at noon.

Ans. Move the hands forward from $11^h\ 30^m$ to $11^h\ 39^m\ 23^s$, as nearly as may be conveniently possible. (The second hand of a watch should always be set so as to be on 60^s when the minute hand is exactly on one of the minute divisions of the dial.)

Ex. 16. Prepare a constant for a meridian observation of β Cassiopeiæ, Dec. 20, 1917, and determine in advance the approximate time for the observation. D. R. latitude, 39° 18′ N., D. R. longitude, 33° 7′ W., both calculated for 8 P.M.; ship steaming 11 knots due E. by compass; variation, 24° W.; deviation, 3° E. Also calculate the latitude, supposing the observed altitude turned out to be 70° 54′, with eye 20 feet and index + 3′. *Ans.* Ship's time of observation, $6^h\ 11^m$ P.M.; lat. = obs'd alt − 31° 19′ = 70° 54′ − 31° 19′ = 39° 35′. The constant is 31° 19′.

Ex. 17. On the ship of Ex. 16, Dec. 20, 1917, at $6^h\ 38^m\ 23^s$ P.M. by the watch, the altitude of Aldebaran or α Tauri was measured, and found to be 33° 25′. $C. - W.$ was $2^h\ 12^m\ 48^s$; chron. fast $2^m\ 26^s$. Find the longitude, using a D. R. latitude; and also run a Sumner line. (Note. The correction for "time past noon" in this example is $1^m\ 27^s$.) *Ans.* Longitude, 33° 13′ W.; Sumner point, latitude, 39° 15′; longitude, 33° 13′; bearing of the line, 6° or 180° + 6°.

Ex. 18. From the Sumner line of Ex. 17 and the latitude of Ex. 16 find the longitude at $6^h\ 11^m$, when the meridian observation was made. *Ans.* 33° 16′.

Ex. 19. A ship is to proceed (p. 19) from Sandy Hook (lat., 40° 28′ N.; long., 73° 50′ W.) to St. Vincent (lat., 16° 50′ N.; long., 25° 7′ W.). A straight line being drawn between these two points on the North Atlantic great circle sailing (or gnomonic) chart (p. 38), it was found to cross the successive principal longitude meridians at the following points:

A, lat., 39° 37′; long., 70° 0′; *B*, lat., 36° 39′; long., 60° 0′;
C, lat., 32° 34′; long., 50° 0′; *D*, lat., 27° 10′; long., 40° 0′;
E, lat., 20° 30′; long., 30° 0′.

The shortest track between Sandy Hook and St. Vincent will therefore pass through these successive points (see p. 38). It is required to calculate logarithmically, by middle latitude sailing (p. 35), the successive courses and distances between these points, so as to compare them with the middle latitude course and distance from Sandy Hook to St. Vincent direct. The middle latitude is to be taken to the nearest minute in each case. *Ans.*

	Course	Dist.
Sandy Hook to *A*	106° 9′	183.3
A to *B*	110° 40′	504.4
B to *C*	116° 23′	551.3
C to *D*	121° 55′	613.0
D to *E*	126° 5′	679.1
E to St. Vincent	128° 24′	354.2
Total distance by great circle sailing		**2885.3**

Middle latitude sailing, Sandy Hook to St. Vincent direct, course, 118° 56′	dist.	2931.0
Apparent saving of distance by great circle sailing,		45.7

It will thus be seen that the great circle course on leaving the Hook is more than a whole compass point to the northward of the middle latitude course, being 106° 9′, instead of 118° 56′.

Ex. 20. A sub-chaser with a cruising speed of 12 knots is bound from Norfolk to New York. While on the way, the navigator is required to find her true course and distance from a point off Winter Quarter Lightship (lat., 37° 54′; long., 74° 54′), to a point off N. E. End Lightship (lat., 38° 56′; long., 74° 27′), *assuming* that a ½-knot flood-current set into the mouth of the Delaware in a N. W. direction during 3 hours of the run.

Ans. If the chaser shaped her course without regard to the tidal current, she would, after running down her distance, be 1½ miles N. W. of her intended destination off N. E. End ship. To avoid this, her course should be shaped for a point 1½ miles S.E. of her intended destination, and then the current will cause her to reach the original desired point. The easiest way to make the calculation is to use the method of traverse sailing (p. 39). This requires that we calculate the latitude difference and departure, separately, both for the ship's run and for the current, and then correct the former with the latter before taking from the traverse table the ship's final course and distance. We first calculate for the run from Winter Quarter to N. E. End, using the latitudes and longitudes given above, and obtain:

	Lat. Diff.	Dep.
For ship's run without regarding current	62.0, northerly;	21.2, easterly;
1½ miles, N.W. current	1.0, northerly;	1.0, westerly;
Subtracting the current effect .	61.0, northerly;	22.2, easterly;

and corresponding to latitude difference 61.0, departure 22.2, the Traverse Table gives true course for the ship 20°, distance 65 miles. The course without regard to current would have been 19°.

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